

## PalArch's Journal of Archaeology of Egypt / Egyptology

### RECENT UPDATES ON IRRITANTS IN ACRYLIC RESINS

*Rinki Susan George<sup>1</sup>, L. Keerthi Sasanka<sup>2</sup>, VenkateshKommi<sup>3</sup>, AnithaRoy<sup>4</sup>*

<sup>1</sup>Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

<sup>2</sup>Senior Lecturer, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, 162, PH Road, Chennai, 600077, Tamil Nadu, India.

<sup>3</sup>Senior Lecturer, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

<sup>4</sup>Associate Professor, Department of Pharmacology Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

<sup>1</sup>151801073.sdc@saveetha.com, <sup>2</sup>keerthis.sdc@saveetha.com, <sup>3</sup>venkateshk.sdc@saveetha.com, <sup>4</sup>anitharoy@saveetha.com

**Rinki Susan George, L. Keerthi Sasanka, VenkateshKommi, AnithaRoy. RECENT UPDATES ON IRRITANTS IN ACRYLIC RESINS--Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(7), 300-308. ISSN 1567-214x**

**Keywords: Contact Dermatitis; Eczematous reaction; Hypersensitivity reactions; Methyl Methacrylate**

#### **ABSTRACT:**

Denture base resins are widely used in dentistry for various purposes such as fabrication of orthodontic removable appliances, temporary crowns, denture relining, denture bases. The acrylic resins are used for removable partial or complete dentures, implant supported dentures. These orthodontic appliances are made for various purposes such as space maintainers and arch expansion. Acrylic temporary crowns are very crucial for the crown and bridge fabrication process. Irrespective of the curing techniques, the presence of unreacted monomers can be the root cause for the allergies in the clinicians and the patients. In order to prevent the cytotoxic effects of these acrylic resins, the curing techniques is carried out for 30 minutes at a maximum temperature for 1-2 days during the polymerisation techniques. The following unreacted monomers cause various side effects like contact dermatitis, hypersensitivity, dizziness, headaches, burning mouth syndrome, stomatitis, neuropathy, sleepiness and blurred visions. It is highly recommended that in areas dealing with these acrylic resins, there is a high need for adequate ventilation to reduce the deterioration of the CNS system. Methyl methacrylate is a potent primary irritant commonly found in the acrylic resin which acts as a sensitizer and causes contact eczematous

reactions on the skin and the oral mucosa. The most reported adverse cases of these include emphysema, edema, collapsing of the lungs. The denture base acrylic resins contain various sensitising substances that cause various allergic reactions. The aim of this review was to bring awareness about the cytotoxic effects of the acrylic resins.

## **INTRODUCTION**

Denture Base acrylic resins are one among the most predominantly used materials in dentistry. They can be classified as chemical, heat, microwave polymerisation materials depending on the polymerisation reaction. Its various applications include denture base construction, Fabrication of Complete and Partial dentures, relining existing dentures, fabrication of orthodontic appliances, mouth guards etc[1]. These resins are used for removable partial dentures and complete dentures. In orthodontic appliances, these resins are used as space maintainers and are used for arch expansion [2]. In restorative dentistry, these are used as cappings. The acrylic resins produce many undesirable effects like allergic reactions such as burning mouth, mouth soreness, burning sensation in the palate, tongue, oral mucosa, oropharynx [3]. The patch tests are done on the skin to confirm these conditions [4]. In cases of immediate and delayed type of hypersensitivity reactions, patch testing, blood tests, or allergen specific IgE tests are carried out [5,6].

The various cytotoxic effects caused by these dentures base acrylic resins are mainly caused because of the substances leaching out from these resins [7]. The main substance which will be leached out by the process of diffusion from these resins is the unreacted acrylic monomer [8]. Therefore the substances which are leached out from the denture bases into the saliva are transferred to oral structures causing adverse allergic reactions [9,10]. This review study was done by selecting 36 more appropriate articles from a collection of 100 articles which was surveyed from various journals and other retrospective studies. The present research study was initiated by reviewing the studies done by the authors based on the Cross sectional studies: [11-14], In vitro studies: [15-18] and Clinical reports: [19,20]. The purpose of this review was to emphasize on the irritants present in the denture acrylic resins.

## **METHODOLOGY**

We conducted a scoping review to draw the information about the irritants present in the denture base acrylic resins.

## **LITERATURE SEARCH AND INCLUSION/EXCLUSION CRITERIA**

The information is retrieved by searching the keywords. Sampling/Data collection was done using the search engines like PubMed, Google Scholar, Cochrane. The article number [13], [21-25] were analysed. The total number of articles searched was 39. Articles related to the denture base acrylic resins classification, synthesis, manipulation, polymerisation techniques, methyl methacrylate, cytotoxic effects, irritants, adverse effects, contact allergy, guidelines for safer use of acrylic resins were included in the study. The exclusion criteria was articles that were not suitable for the given study. The keywords used were contact dermatitis, eczematous reaction, hypersensitivity

reactions, methyl methacrylate. All the articles are collected, explored and summarized.

### **CLASSIFICATION OF DENTURE BASE RESINS**

McCabe and Wall had classified the denture base polymers into the following five types: Type 1-Heat cure polymers, Type 2-Self cured polymers, Type 3-Thermoplastic resins, Type 4-Light activated resins, Type 5-Microwave cured resins.

There are various ingredients within the powder and the liquid which includes methyl methacrylate. It is recommended that the amount of residual monomer is reduced before the insertion of the dentures and suggested that the health professionals must instruct their patients that the newly made dentures are not to be worn overnight so as to avoid mucosal irritation caused due to leachable residual monomer molecule. It was reported that the self cured resins leach out higher quantities of residual monomers than heat cured denture base resins [26,27].

### **PRIMARY IRRITANT - METHYL METHACRYLATE**

Methyl Methacrylate is a potent primary irritant that acts as a sensitizer and causes contact eczematous reactions on the skin and the oral mucosa. Several studies have reported that methyl methacrylate monomer causes hypersensitivity reactions as well as local irritation, while completely polymerised methyl methacrylate doesn't cause such reactions [28].

### **POLYMERISATION REACTION AND RESIDUAL MONOMER**

The polymerisation reaction in acrylic resins is a type of addition reaction that involves the activation of the initiator. It results in the conversion of Methyl Methacrylate [MMA] into poly-MMA during which the monomer molecules are converted into polymers [29]. The reaction is exothermic and the polymerization temperature is another factor that plays a major role in creating cytotoxic effects [30]. When the polymerization time extends, the amount of unreacted monomer gets reduced significantly and the chances of the cytotoxic effects are reduced [31]. Evidence from previous studies have proved that the long curing with terminal boiling, polishing, and storing the conventional PMMA at +37°C for at least 24 h reduces the monomer content to permissible levels.

Residual monomers are left in the polymer, might leach out into human saliva from the denture or appliance, this leached residual monomer is capable of various degrees of in vitro cytotoxicity and in vivo allergic responses depending on its leftover percentage.

### **HARMFUL CYTOTOXIC EFFECTS**

Patch testing is a reliable way to distinguish these allergic reactions. Since the acrylic resins is the main component in various dental appliances, the patients tend to encounter several allergic reactions. The unreacted monomer leaches out into the oral cavity and causes contact dermatitis, stomatitis, hypersensitivity reaction, burning mouth sensation, sore mouth etc. These can cause significant damage to the cell membrane, mitochondria, lymphocytes at cellular level [32,33].

The presence of the saliva in the oral cavity provides the essential defensive barrier by

diluting all potential harmful antigens before their penetration into the oral mucosa. The effect of these penetrated irritants is reduced due to the high vascular nature of the oral mucosa. However, it will mainly depend on the concentration of the residual monomer. Therefore it's important that the auto polymerised resins are immersed in water before inserting it into the patient's mouth. The cytotoxic effects of denture base acrylic resins are related to powder to liquid ratio, storage time, polymerization method, and polymerisation cycle. The greater the monomer in the mix the higher the cytotoxic effects of the resin. The residual monomer content in the self cure resins is 1-4%, and in heat cure resins it will be around 1-3% to < 0.4% depending on the type of the processing.

The storage time was one of the most important factors that imparts the cytotoxic effects, longer the storage time lesser the cytotoxic effects. This can be due to breakdown of the residual monomer by forming the complexes with other substances in water, which happens in the first 24 hours of storage. Therefore it is recommended that clinicians deliver the prosthesis or appliances only after storing them for 24 hrs in water. For autopolymerizing resins or self cure resins it is recommended that immersion of the appliance at 50<sup>0</sup>C for 60 mins to reduce the residual monomer which eventually reduces the cytotoxicity of the resin. The polymerisation cycle also plays an important role in reducing cytotoxic effects, the heat cure resins are less toxic than cold cure, light cure and microwave cured resins. In the heat cure resins the least possible cytotoxicity will be in long curing cycles rather than short curing cycles [34,35].

#### **OTHER ADVERSE EFFECTS OF METHYL METHACRYLATE**

During manipulation of these acrylic resins, the inhalation of these Methyl Methacrylate monomers causes harmful effects on the central nervous system. These also cause clinical conditions like emphysema, edema, and even collapsing of the lungs [36].

The dental technicians and other health professionals on exposure to these Methyl Methacrylate monomers develop conditions such as dyspnoea, cough, asthma. These Methyl Methacrylate monomers can penetrate into the skin and cause direct neurotoxic effects. Certain myelinated nerve functions get affected by methacrylate monomers which are absorbed directly from the skin and cause neuropathy [37]. The most common brands of acrylic resins are TPA-696, LUCITE 30B, TSA-1003, AROLON-2107, DPI Heat Cure and Cold Cure. The companies that are associated with these supplies include Kulzer, Dentsply, Trevalon.

#### **CONTACT ALLERGY**

Contact allergy is seen in denture wearers which is caused mainly because of delayed hypersensitivity reactions. Symptoms for these conditions include burning mouth syndrome, mouth soreness. For dental technicians and other health professionals the usage of Methyl Methacrylate causes direct effects on the skin and oral mucosa [38]. These effects are normally dependent on the time of exposure. The monomer penetrates through the latex gloves and

becomes a source of irritation for the skin of the clinicians and the technicians [31].

### **THE GUIDELINES FOR SAFER USE OF ACRYLIC RESINS [39]**

1. It is recommended to use a well ventilated area where the acrylic resins are manipulated - good ventilations reduces the vaporization effects of the monomers.
2. Protective eyewear, impermeable gloves and aprons should be mandatory while handling denture base resins.
3. Monomers should be sealed in tightly closed containers
4. In case of direct contact with monomers, the area should be thoroughly washed, in case of contact with eyes - if contact lenses were used, remove immediately and rinse with water.
5. Remove tight clothing, stay in a ventilated area to breathe fresh air, if there is a spill appropriate cleaning agents should be used.
6. Vacuum mixing is recommended along with proper curing techniques
7. Seek a medical professional immediately if there is any allergy or irritation in the area of contact.

### **CONCLUSION**

Denture Base Resins are acrylic resins that are widely used in fabrication of prosthesis, however they cause toxic side effects in some patients. Irrespective of their curing techniques, the presence of unreacted residual monomers is inevitable and can be a source of problem for clinicians and patients who are exposed to those allergens. During the polymerisation technique, the curing procedure can be carried out for 30 minutes at maximum temperature for 1-2 days before delivering it to the patients. This will reduce the cytotoxic effects caused by these unreacted reduced MMA. The unreacted MMA monomers cause the following conditions such as contact dermatitis, local irritation, burning mouth syndrome, neuropathy. In certain cases, the ingestion of the Methyl Methacrylate can cause CNS effects such as sleepiness, dizziness, headache and blurred vision. Several studies reported that the gloves worn for infection control have no effect over the contamination by those monomers. The latex gloves become a source of irritation to the skin for the clinicians and technicians. It is highly recommended that the areas where denture resins are used, must be thoroughly ventilated. Gloves, aprons and the protective eyewear must be used during the procedure. In case of any contact made, the clinician and the patients must move to an area with fresh air and loosen up tight clothing to facilitate breathing. The denture base resins contain various sensitising substances that cause various allergic reactions. Hence it is necessary that specific emphasis must be given among the dental staff and technicians about the possible hazardous side effects of the acrylic denture base resins

### **ACKNOWLEDGEMENTS**

This work was based on the views and comments given among the authors.

All the authors would like to thank the editors and the authors of the Journal which was indeed a source for the scientific compilation of this review article.

### **AUTHORS CONTRIBUTION**

Rinki Susan George, carried out the study by collecting journal ,scientific articles and drafted the manuscript after the necessary corrections. Dr. L.KeerthiShashank and Dr.VenkateshKommi aided in conception of the topic, they have also participated in the study design and have supervised in the preparation of the manuscript. Dr.Anitha Roy has guided in the study design as well and has also coordinated in the development of the manuscript. All the authors have discussed the study among themselves and contributed to the making of the final manuscript.

### CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

### REFERENCES

- Bayraktar G, Guvener B, Bural C, Uresin Y. Influence of polymerization method, curing process, and length of time of storage in water on the residual methyl methacrylate content in dental acrylic resins. *J Biomed Mater Res B Appl Biomater* 2006;76:340–5. <https://doi.org/10.1002/jbm.b.30377>.
- Urban VM, Machado AL, Vergani CE, Giampaolo ET, Pavarina AC, de Almeida FG, et al. Effect of water-bath post-polymerization on the mechanical properties, degree of conversion, and leaching of residual compounds of hard chairside reline resins. *Dent Mater* 2009;25:662–71. <https://doi.org/10.1016/j.dental.2008.10.017>.
- Nironen P. Some possible uses for acrylic resins in dentistry. *OdontolTidskr* 1950;58:118–25.
- Faltermeier A, Rosentritt M, Müssig D. Acrylic removable appliances: comparative evaluation of different postpolymerization methods. *Am J Orthod Dentofacial Orthop* 2007;131:301.e16–22. <https://doi.org/10.1016/j.ajodo.2006.07.019>.
- Luo Y, Wang W, Yang Z. [Clinical evaluation of two temporary restoration materials: Composite and self-cured acrylic resin]. *Hua Xi Kou Qiang Yi XueZaZhi* 2003;21:222–5.
- Tanoue N, Matsuda Y, Yanagida H, Matsumura H, Sawase T. Factors affecting the bond strength of denture base and reline acrylic resins to base metal materials. *J Appl Oral Sci* 2013;21:320–6. <https://doi.org/10.1590/1678-775720130134>.
- Devaki V, Manonmani P, Balu K, Aravind R. Clinical management of highly resorbed mandibular ridge without fibrous tissue. *Journal of Pharmacy and Bioallied Sciences* 2012;4:149. <https://doi.org/10.4103/0975-7406.100256>.
- Gonçalves TS, Morganti MA, Campos LC, Rizzato SMD, Menezes LM. Allergy to auto-polymerized acrylic resin in an orthodontic patient. *American Journal of Orthodontics and Dentofacial Orthopedics* 2006;129:431–5. <https://doi.org/10.1016/j.ajodo.2005.10.017>.
- Usmani N, Wilkinson SM. Allergic skin disease: investigation of both immediate- and delayed-type hypersensitivity is essential. *Clin Exp Allergy* 2007;37:1541–6. <https://doi.org/10.1111/j.1365-2222.2007.02805.x>.

- Chaves C de AL, Machado AL, Vergani CE, de Souza RF, Giampaolo ET. Cytotoxicity of denture base and hard chairside reline materials: a systematic review. *J Prosthet Dent* 2012;107:114–27. [https://doi.org/10.1016/S0022-3913\(12\)60037-7](https://doi.org/10.1016/S0022-3913(12)60037-7).
- Jyothi S, Robin PK, Ganapathy D, Anandiselvaraj. Periodontal Health Status of Three Different Groups Wearing Temporary Partial Denture. *Research Journal of Pharmacy and Technology* 2017;10:4339. <https://doi.org/10.5958/0974-360x.2017.00795.8>.
- Ashok V, Suvitha S. Awareness of all ceramic restoration in rural population. *Research Journal of Pharmacy and Technology* 2016;9:1691–3.
- Kannan A, Venugopalan S. A systematic review on the effect of use of impregnated retraction cords on gingiva. *Research Journal of Pharmacy and Technology* 2018;11:2121. <https://doi.org/10.5958/0974-360x.2018.00393.1>.
- Basha FYS, Ganapathy D, Venugopalan S. Oral Hygiene Status among Pregnant Women. *Research Journal of Pharmacy and Technology* 2018;11:3099. <https://doi.org/10.5958/0974-360x.2018.00569.3>.
- Duraisamy R, Krishnan CS, Ramasubramanian H, Sampathkumar J, Mariappan S, Navarasampatti Sivaprakasam A. Compatibility of Nonoriginal Abutments With Implants: Evaluation of Microgap at the Implant-Abutment Interface, With Original and Nonoriginal Abutments. *Implant Dent* 2019;28:289–95. <https://doi.org/10.1097/ID.0000000000000885>.
- Ganapathy D, Sathyamoorthy A, Ranganathan H, Murthykumar K. Effect of Resin Bonded Luting Agents Influencing Marginal Discrepancy in All Ceramic Complete Veneer Crowns. *J Clin Diagn Res* 2016;10:ZC67–70. <https://doi.org/10.7860/JCDR/2016/21447.9028>.
- Ranganathan H, Ganapathy DM, Jain AR. Cervical and Incisal Marginal Discrepancy in Ceramic Laminate Veneering Materials: A SEM Analysis. *Contemp Clin Dent* 2017;8:272–8. [https://doi.org/10.4103/ccd.ccd\\_156\\_17](https://doi.org/10.4103/ccd.ccd_156_17).
- Ajay R, Suma K, Ali S, Sivakumar JK, Rakshagan V, Devaki V, et al. Effect of surface modifications on the retention of cement-retained implant crowns under fatigue loads: An In vitro study. *Journal of Pharmacy And Bioallied Sciences* 2017;9:154. [https://doi.org/10.4103/jpbs.jpbs\\_146\\_17](https://doi.org/10.4103/jpbs.jpbs_146_17).
- Ashok V, Nallaswamy D, Benazir Begum S, Nesappan T. Lip Bumper Prosthesis for an Acromegaly Patient: A Clinical Report. *J Indian Prosthodont Soc* 2014;14:279–82. <https://doi.org/10.1007/s13191-013-0339-6>.
- Venugopalan S, Ariga P, Aggarwal P, Viswanath A. Magnetically retained silicone facial prosthesis. *Niger J Clin Pract* 2014;17:260–4. <https://doi.org/10.4103/1119-3077.127575>.
- Ariga P, Nallaswamy D, Jain AR, Ganapathy DM. Determination of Correlation of Width of Maxillary Anterior Teeth using Extraoral and Intraoral Factors in Indian Population: A Systematic Review. *World Journal of Dentistry* 2018;9:68–75. <https://doi.org/10.5005/jp-journals-10015-1509>.
- Selvan SR, Ganapathy D. Efficacy of fifth generation cephalosporins against methicillin-resistant *Staphylococcus aureus*-A review. *Research*

- Journal of Pharmacy and Technology 2016;9:1815.  
<https://doi.org/10.5958/0974-360x.2016.00369.3>.
- Subasree S, Murthykumar K, Dhanraj. Effect of Aloe Vera in Oral Health-A Review. Research Journal of Pharmacy and Technology 2016;9:609.  
<https://doi.org/10.5958/0974-360x.2016.00116.5>.
- Vijayalakshmi B, Ganapathy D. Medical management of cellulitis. Research Journal of Pharmacy and Technology 2016;9:2067.  
<https://doi.org/10.5958/0974-360x.2016.00422.4>.
- Ganapathy DM, Kannan A, Venugopalan S. Effect of Coated Surfaces influencing Screw Loosening in Implants: A Systematic Review and Meta-analysis. World Journal of Dentistry 2017;8:496–502.  
<https://doi.org/10.5005/jp-journals-10015-1493>.
- McCabe JF, Walls AWG. Applied Dental Materials. John Wiley & Sons; 2013.
- Pfeiffer P, Rosenbauer E-U. Residual methyl methacrylate monomer, water sorption, and water solubility of hypoallergenic denture base materials. J Prosthet Dent 2004;92:72–8.  
<https://doi.org/10.1016/j.prosdent.2004.04.003>.
- Lung CYK, Darvell BW. Methyl methacrylate monomer-polymer equilibrium in solid polymer. Dent Mater 2007;23:88–94.  
<https://doi.org/10.1016/j.dental.2005.12.004>.
- Çelebi N, Yüzügüllü B, Canay Ş, Yücel Ü. Effect of polymerization methods on the residual monomer level of acrylic resin denture base polymers. Polymers for Advanced Technologies 2008;19:201–6.  
<https://doi.org/10.1002/pat.996>.
- Bural C, Aktaş E, Deniz G, Ünlüçerçi Y, Bayraktar G. Effect of leaching residual methyl methacrylate concentrations on in vitro cytotoxicity of heat polymerized denture base acrylic resin processed with different polymerization cycles. J Appl Oral Sci 2011;19:306–12.  
<https://doi.org/10.1590/s1678-77572011005000002>.
- Nik TH, Shahroudi AS, Eraghihzadeh Z, Aghajani F. Comparison of residual monomer loss from cold-cure orthodontic acrylic resins processed by different polymerization techniques. J Orthod 2014;41:30–7.  
<https://doi.org/10.1179/1465313313Y.00000000078>.
- Golbidi F, Asghari G, Others. The level of residual monomer in acrylic denture base materials. Research Journal of Biological Sciences 2009;4:244–9.
- Lung CYK, Darvell BW. Minimization of the inevitable residual monomer in denture base acrylic. Dent Mater 2005;21:1119–28.  
<https://doi.org/10.1016/j.dental.2005.03.003>.
- Lamb DJ, Ellis B, Priestley D. The effects of process variables on levels of residual monomer in autopolymerizing dental acrylic resin. Journal of Dentistry 1983;11:80–8. [https://doi.org/10.1016/0300-5712\(83\)90051-9](https://doi.org/10.1016/0300-5712(83)90051-9).
- Sadamori S, Shigeto N, Hamada T, Okuda K. A method of determining residual monomer in acrylic resin using methyl ethyl ketone. Australian Dental Journal 1990;35:509–13.  
<https://doi.org/10.1111/j.1834-7819.1990.tb04681.x>.
- Koutis D, Freeman S. Allergic contact stomatitis caused by acrylic monomer in a denture. Australas J Dermatol 2001;42:203–6.  
<https://doi.org/10.1046/j.1440-0960.2001.00517.x>.



- Singh RD, Gautam R, Siddhartha R, Singh BP, Chand P, Sharma VP, et al. High Performance Liquid Chromatographic Determination of Residual Monomer Released from Heat-Cured Acrylic Resin. An In Vivo Study. *Journal of Prosthodontics* 2013;22:358–61. <https://doi.org/10.1111/jopr.12004>.
- Kanerva L. Cross-reactions of multifunctional methacrylates and acrylates. *Acta Odontol Scand* 2001;59:320–9. <https://doi.org/10.1080/000163501750541200>.
- 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. <https://doi.org/10.4103/1305-7456.172621>.