



Knowledge and Application use of Modified Monomer Acrylic Denture Base Resin among Dental Practitioners: A Survey

Varusha Sharon Christopher ^a, Rakshagan V. Reader ^{b*}, M. Jeevitha ^b and Selvaraj Jeyaraman ^c

^a *Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai -77, India.*

^b *Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai -77, India.*

^c *Department of Biochemistry, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai -77, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Several modifications to the denture base PMMA resins have been tried in recent years to improve the physico-mechanical and biological qualities. Polymer and monomer alterations are two types of modifications that can be found. Advances in polymer science have resulted in innovative polymers with higher impact strength and fatigue resistance, high-impact polymers and fiber-reinforced polymers, for example. This survey tries to determine the level of knowledge and awareness on the applications of these modified monomers in acrylic denture base resin among dental practitioners.

Keywords: *Denture base; modifications; tensile; anti-bacterial; acrylic.*

1. INTRODUCTION

Dental materials are essential in the practise of prosthetic dentistry. Since the beginning of time, they have been closely linked. Prosthodontists are the ones that deal with a wide variety of materials. A good dentist can recognise and use any material, but a good prosthodontist is a skilled chemist who understands material reactions and manipulations. A prosthodontist and denture base acrylic resins have a lifelong friendship.

For the past 60 years the most often used denture base material is poly(methyl methacrylate) (PMMA). Despite the fact that different denture base polymers have been developed and brought into dentistry to solve PMMA resin's shortcomings, it has remained the preferred material for denture base manufacture [1]. The widespread consumption of PMMA resin is due to its combination of numerous desirable features, even though its properties are not optimal in every way [2].

Several study looked into the drawbacks of PMMA resin that has been heat-cured in terms of strength, particularly under the influence of weariness and impact circumstances [3]. Denture fracture might be avoided by using alternative materials with significantly increased strength, yet it could be minimised by using suitable denture design and manufacture processes.

Several modifications to the denture base PMMA resins have been tried in recent years to improve the physico-mechanical and biological qualities [4]. Polymer and monomer alterations are two types of modifications that can be found. Advances in polymer science have resulted in innovative polymers with higher impact strength and fatigue resistance, high-impact polymers and fiber-reinforced polymers, for example [5]. Inorganic fillers such as metallic oxides, fluorinated glass fillers, hydroxyapatite whiskers, zirconia, and carbon/graphite, aramid, ultra-high modulus polyethylene, nylon, and jute are used to modify the polymer [2,6]. In the dental literature, there are reviews of investigations on polymeric alterations. However, there are currently no much literature reviews on monomer modification.

This survey tries to determine the level of knowledge and awareness on the applications of these modified monomers in acrylic denture base resin among dental practitioners.

Our department has already published considerable research on a variety of prosthetic dental topics [7–17]. This extensive research background has prompted us to investigate dental students' knowledge of the uses of these modified monomers in acrylic denture base resin.

2. MATERIALS AND METHODS

2.1 Study Design

All students in years I, II, III, and IV BDS, as well as interns and post-graduates, were invited to participate in the study.

2.2 Sampling Technique

A non-probability consecutive sampling strategy was used in the investigation. All replies were evaluated and incorporated to reduce sample bias.

2.3 Data Collection and Tabulation

The poll was performed using Google Forms, an online platform. All data were included to reduce sampling bias. The data was taken from Google Forms and imported into Excel, where it was tabulated. The data was tallied and analysed.

3. RESULTS AND DISCUSSION

The survey involved 120 students, and the data were gathered and examined. Twenty percent of the 120 participants were I BDS, twenty percent were II BDS, twenty percent were III BDS, twenty percent were IV BDS, twenty percent were interns, and twenty percent were post-graduates. [Fig. 1]. All the figures in response whether they were aware of modifications present in polymer used in dentures bases [Fig. 2], if yes what are compounds they knew used in modification of polymers [Fig. 3], whether they were aware of modification present in monomers used in denture bases [Fig. 4], if yes what compound they knew which are used in bringing out the modifications [Fig. 5], whether they knew what are chemical, physical and chemical properties that are enhanced with these modifications [Fig. 6] and whether they knew any commercially available modified monomers and polymers used in denture bases [Fig. 7].

Students from the academic years I BDS, II BDS, III BDS, IV BDS, and CRRI were involved in the study to compare their understanding of the modifications found in these polymers and monomers. I'm not sure how much I'd know about BDS because they mostly focus on fundamental science. Because students study preclinical prosthodontics and dental materials in their curriculum, II BDS would have a bit more understanding than I BDS. III BDS, IV BDS, CRRI, and post-graduates are more aware than the other two categories, as seen by their responses.

As for compounds used in polymer modifications, students were given multiple options including rubber, styrene, metallic oxides, fluorinated glass fibres zirconia and organic fibres. As for compounds used in monomer modifications, options given were fluromonomers, phosphate monomers, methacrylic acid, nitromonomer, quaternized ammonium monomer, Dimethylaminododecyl methacrylate, Dimethyl ammonium ethyl dimethacrylate, bisphenol A-glycidyl methacrylate (Bis-GMA), Norbonyl/phenyl methacrylate (NBMA& PHMA) and Methacryloyloxyundecyl pyridinium bromide (MUPB). For the properties these modifications enhance options given were Reduce water absorption, Increases anti-microbial activity, Increase surface hardness, Increase biocompatibility and Increase flexural strength. Their knowledge was assessed on how much compounds they were able to list out.

Because of the fluorine ions, fluoromonomers have an intrinsic trait of "water-shedding," making them hydrophobic and useful in the realm of dental prosthetics. This is a unique technique that involves substituting fluoromonomers in MMA to reduce water sorption, reduce the acute contact angle, and thereby reduce microbial adhesion, particularly Candidal adhesion, in the case of denture stomatitis [18]. In order to minimise water sorption and solubility in the oral environment, as well as Candidal adhesion, these monomers were also added in the proprietary monomers of denture soft/resilient liners [19].

When phosphate monomers were added to MMA, it resulted in increased water sorption, solubility, and acute contact angles. These findings suggest that these monomers are naturally hydrophilic [20]. In terms of colour stability and staining, these monomers performed admirably. Although mechanical properties including flexural strength, impact strength, and

fracture toughness were diminished, there were no negative repercussions, showing its clinical limitations [21]. It's also an antifungal monomer, since it prevents *Candida albicans* from adhering to surfaces and colonising them [22].

Methacrylic acid (MAA) is a monomer that is substituted in MMA to act as an antibacterial. MAA exhibited a more acute contact angle and reduced microbial adherence [23]. This monomer's hydrophilicity must be thoroughly investigated in terms of water sorption and solubility [24]. The surface roughness improved once MAA was replaced. When added to MMA, chemical characterisation and copolymerization were exhibited. Surface hardness was reduced as a result of MAA [25].

Nitromonomer is a novel term that has been coined for the purpose of explaining monomers containing nitrogen, such as amino/ammonium/pyridinium or amides. Antimicrobial monomers can also be used to these monomers [26]. When 2-tert-butylaminoethyl methacrylate (TBAEMA) was added to MMA, it caused copolymerization and a high N2 ratio. At higher concentrations, there was also a decrease in flexural strength, Tg, and an increase in water sorption. DMAEMA-OB, a quaternized ammonium monomer, was found to be efficient against both gram-positive and gram-negative bacteria and fungi. 2-(methacryloyloxy) ethyl trimethyl ammonium chloride (MADQUAT), another quaternized ammonium anti-microbial monomer (QAM), was found to be an effective antifungal monomer with both fungistatic and fungicidal properties [27].

Antibacterial properties of dimethylamino dodecyl methacrylate (DMADDM) and dimethyl ammonium ethyl methacrylate (DMAEDM) were discovered. The cytotoxicity of both monomers was much lower than that of bisphenol A-glycidyl methacrylate (Bis-GMA) [28]. The antimicrobial denture base monomer DMADDM was found to be effective against the production of multispecies biofilm on denture surfaces [29]. It altered the structure of multi-biofilms and decreased *C. albicans* biofilm metabolic activity, hyphal growth, and the production of virulence-related genes. At a concentration of 1.65–3.3 percent, it also lowered Candidal receptors on host cells, minimising cell damage and being biocompatible [30]. By putting it into dental restorative materials, methacryloyloxyethyl cetyl dimethyl ammonium chloride (DMAE-CB) can be employed as an antibacterial monomer.

In dentistry, two pyridinium-based nitromonomers were utilised. The addition of methacryloyloxyundecylpyridinium bromide (MUPB) to MMA lowered flexural strength but had no effect on surface roughness, hardness, or colour stability [31]. Hydrophobic monomers

NBMA and PHMA reduced water sorption and increased mechanical characteristics. Norbonyl compounds polymerize through ring-opening metathesis polymerization, which may explain why NBMA with MMA showed reduced polymerization shrinkage (ROMP) [32].

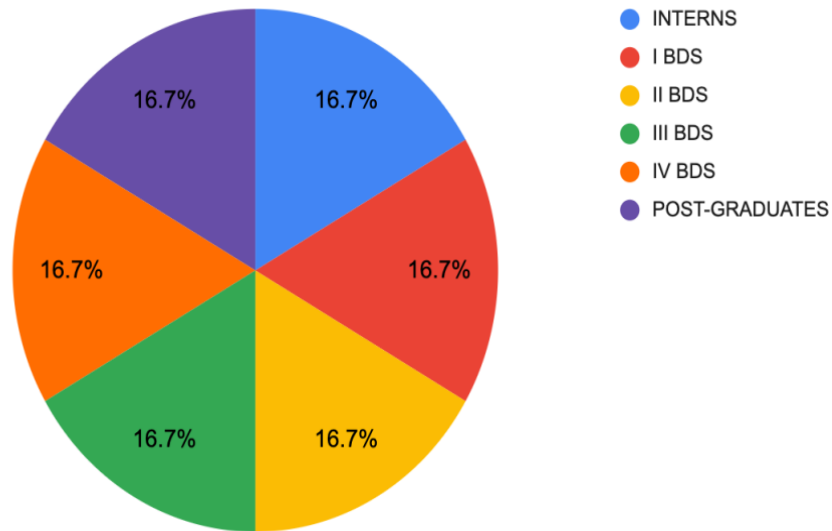


Fig. 1. This pie chart depicts the demographics of the research participants, with blue denoting interns, red denoting I BDS, yellow denoting II BDS, green denoting III BDS, orange denoting IV BDS, and purple denoting post-graduates. 16.7% of the population falls into each of these categories

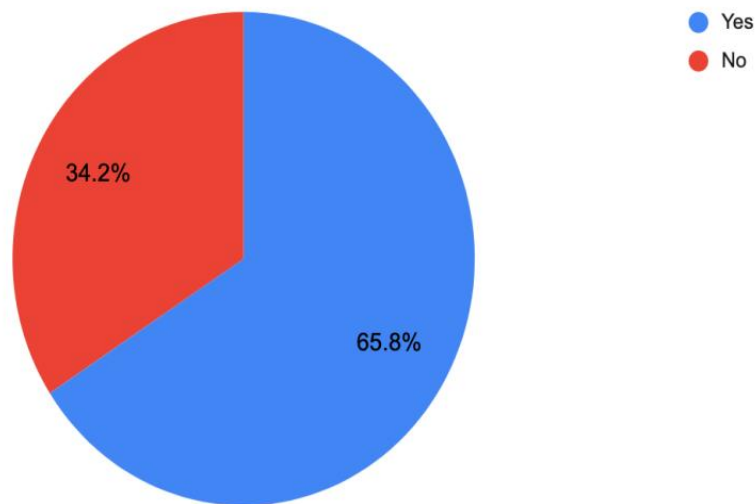


Fig. 2. This pie chart represents the responses for the question whether they were aware of any modifications present in polymers that are used in denture bases where blue denotes yes and red denotes red. 65.8% of the population was aware of modified polymers and 34.2% was not aware

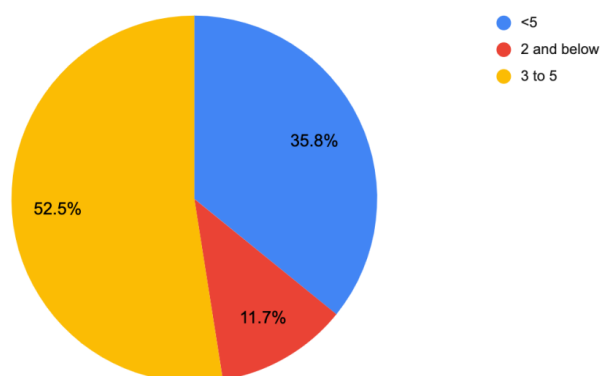


Fig. 3. This graph shows the responses on how many compounds the student knew that are used in modifying polymers where blue denotes the population that know above 5, red denotes the population that 2 and below and yellow denotes the population that knew around 3 to 5. 52.5% of the population knew between 3 to 5, 35.8% of the population knew above 5 compounds and 11.7% of the population knew 2 and below

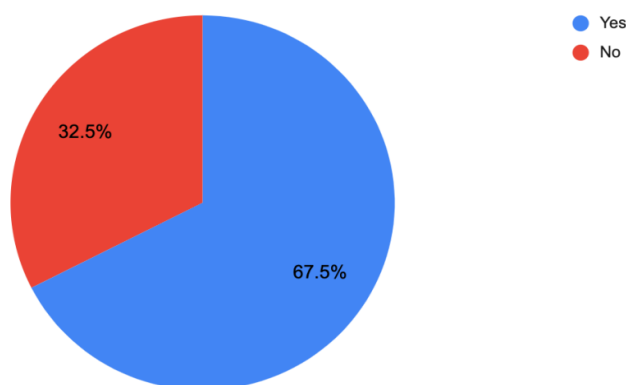


Fig. 4. This graph shows the responses on whether they were aware of the modifications present in the monomers that were used in denture bases where blue denotes yes and red denotes NO. 67.5% of the population was aware about the modifications and 32.5% was not aware

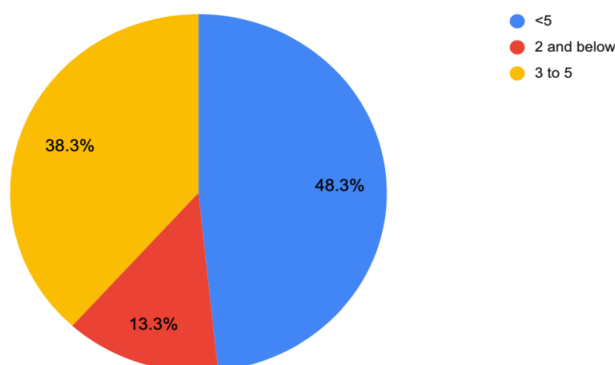


Fig. 5. This graph shows the responses on how many compounds the students knew that are used in modifying monomers where blue denotes the population that know above 5, red denotes the population that knew 2 and below and yellow denotes the population that knew around 3 to 5. 38.3% of the population knew between 3 to 5, 48.3% of the population knew above 5 compounds and 13.3% of the population knew 2 and below

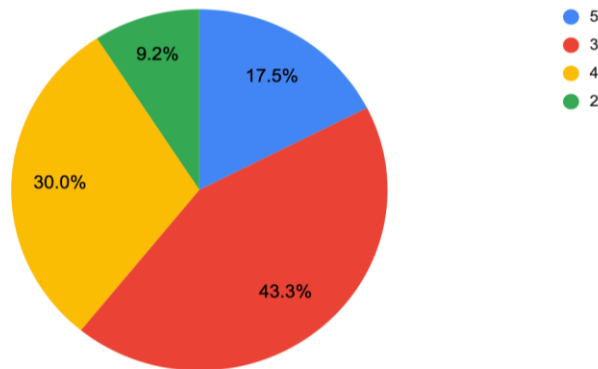


Fig. 6. This graph represents the knowledge on the properties that these modification can bring about in the denture bases where blue denotes the population that knew 5 properties, yellow denotes the population that knew 4 properties, red denotes the population that knew 3 properties and green denotes the population that knew 2 properties. 43.3% of the population knew 3 properties, 30% of the population knew 3 properties, 17.5% knew all the 5 properties and 9.2% of the population knew 2 properties

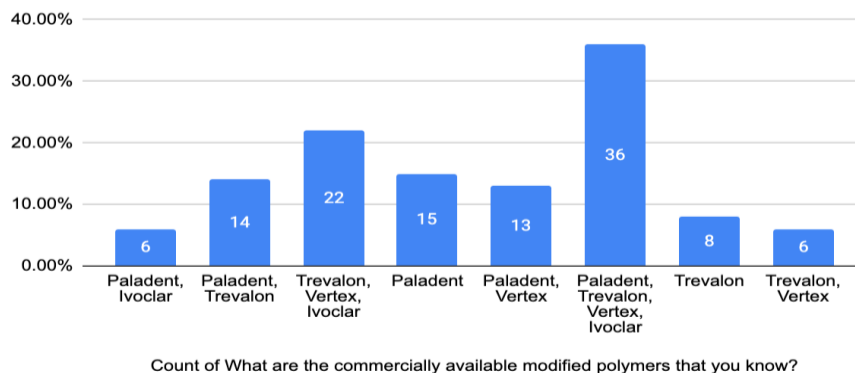


Fig. 7. The bar graph represents the knowledge of the population about the commercial availability of these modified polymers and monomers that is used in making denture bases

4. CONCLUSION

The survey helped the students to understand the various modifications in monomer and polymers for making a denture base. They got to know the various uses of each modification and the impact of that modification in the physical and chemical integrity of the denture base. Hence more information regarding this facts in their curriculum would help them to expand their knowledge and their way of manipulating with the material so that they are more versatile with these materials.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The Institutional Ethics Committee gave its clearance to the study [SDC/SIHEC/2020/DIASDATA/0619-0320]. One reviewer, one assessor, and one guide were involved in the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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