Functional modifications of denture base resin - A review

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ABSTRACT

In the year 1930s, acrylic resins were established. The materials used for denture base are vulcanite, celluloid & phenol-formaldehyde. The limitations were found those were high coefficient of thermal expansion, thermal shrinkage, poor colour stability of self-cured resins, porosity, crazing, warpage, poor adhesion to metal and porcelain retention. Denture base resins are widely used till date as it has its own significance. But recently there has been much advancement in the denture base resin field to control and to invent a new denture base resin. Methyl methacrylate chemical compound of denture base resins was changed with many monomers to attain higher physicomechanical properties while not compromising the biocompatibility. However, there is not any consensus on the most effective strategy to attain the best changed chemical compound, to identify and evaluate the variations within the properties between typical and changed monomers and to verify the effect of many variables on the properties of dental plate base acrylic. The present review shows the different advancements in the area of denture base resins.

INTRODUCTION

Acrylic resins were proposed by Dr. Walter Wright and Vernon Brothers in Philadelphia. In 1936, transparent resin came into existence and also acrylic powder came into use in 1937. 95% of dentures were made by them. Polymethyl methacrylate, due to its extraordinary aesthetics and ease of processing & repair it was considered as the basic denture base material used in dentistry (Kostoulas et al., 2008). Certain properties such as poor colour stability of self-cured resins, porosity, crazing, warpage, poor adhesion to metal, and porcelain retention were the major disadvantages of this material (Petrescu, 2010). In the area of denture base resins, the new modifications have been made to overcome the problem. To control the problems of monomer allergy, the hypoallergenic resins were used (Rodriguez, 2013). By using gum toning in the resins can improve denture aesthetics. The present review shows the different growth in the area of denture base resins.
Modifications Of Denture Base Resins

A. Enigma gum toning in denture bases
B. Resins with a modified chemical structure
C. Thermoplastic resins
   1. Thermoplastic nylon
   2. Thermoplastic acetal
   3. Thermoplastic acrylic
   4. Thermoplastic polycarbonate
D. Hypoallergenic resins
E. Reinforced resins
   1. Fiber-reinforced
   2. High impact resins (Karacaer, 2003)

Enigma Gum Toning

These Enigma gum toning colour tones were better in custom shade matching of natural gingival tissue. It provides extra confidence to the patients in the aesthetics of their dentures. These exist in different shades such as ivory, light pink, natural pink, dark pink & light brown shade. These are also very comfortable in aesthetic and health in pregnant women.

Resins With Modified Chemical Structure

Hydroxyapatite fillers are added to increase fracture toughness. The addition of Al2O3 fillers is to increase the flexural strength & thermal diffusivity that could lead to more patient satisfaction. The powder to the liquid ratio by weight is 2.2:1 is the best mix for better treatment for geriatric patients for better oral health. The new additive is triphenyl bismuth (Ph3Bi) which gives radiopacity (Ashok and Suvitha, 2016). Abutment taper, screw access channel engagement, height, axial wall number, abutment platform, and surface roughness are the predominant modification variables of implants supported dentures (Basha et al., 2018; Ajay, 2017).

Thermoplastic Resins

Thermoplastic resins are very much advantageous compared to conventional powder-liquid system. They possess magnificent aesthetics which match the tooth structure or tissue coloured material and these materials show a very pleasant feel to the patients. There is no growth of bacteria because they are non porous and although they are non porous to keep them comfortable to patients against their gums they retain a slight amount of moisture.

These resins were very strong and are unbreakable and it also has higher flexibility and also lesser weight. These resins are very little and also it doesn't have monomer material and also it is an alternative resin to conventional resins. They may also be relined & repaired by repressing the restoration (Ashok, 2014).

Thermoplastic Nylon

Polyamide is the basic material used in thermoplastic nylon. The first flexible thermoplastic, teflon is introduced in thermoplastic resin by the usage of a rapid injection system. It is used for the fabrication of dental appliances. The framework for standard removable partial dentures is built by the pink acrylic denture material. Valplast & flexplate are polyamides (nylon plastics). Tooth-coloured clasp known as clasp-Eze which is made of nylon material was manufactured and patented by the flexite company in 1992 was the first preformed. It is available for both clear shades and pink colour.

Limitations

Thermoplastic nylon materials were very hard to polish. Conventional tooth-borne rest seats are stronger than thermoplastic nylon.

Thermoplastic Acetal

In 1971 acetal was first proposed as an unbreakable thermoplastic resin. Rapid injection develops the first tooth-coloured clasps with a thermoplastic fluoropolymer. It has good short-term mechanical properties as a homopolymer, but has better long-term stability as a co-polymer.

Mechanism Of Action

Resin clasps are to be placed more gingivally, to increase its aesthetic appeal beyond the obvious coloured properties.

Thermoplastic Acrylic

Thermoplastic acrylic has very poor impact resistance and excellent flexural and tensile strength. These resins are very popular due to their translucency and vitality. These resins are also best for their aesthetics, very easy to handle, polish and adjust. These acrylics exist in various tooth colours and different gingival colours. These materials are reliable and repairable in its clinical aspects. Flexite M.P is a type of thermoplastic acrylic and it is a special blend of polymers. These were very well known for bruxism appliances as well as dentures because these are unbreakable even it falls and also have the greatest impact rating of any acrylic. These are used in advancements of denture base resins recently by using nanoparticles in denture bases (Venugopalan, 2014; Kannan and Venugopalan, 2018).
Thermoplastic Polycarbonate  
Polymer chain of bisphenol-alpha carbonate is known as polycarbonate. Polycarbonate resin is similar to the acetal resin and is also very strong, resists fracturing and is quite flexible. Polycarbonate is not worn as well as acetal during occlusal force and consequently will not maintain for long durations in vertical dimensions. Polycarbonate is ideal for provisional crown & bridges but not suitable for full or partial dentures. The polycarbonate has a natural translucency and also finishes very well, yielding excellent aesthetics. It has the best aesthetic properties.

Applications Of Thermoplastic Resins  
There are various applications of thermoplastic resins those are to performs partial denture clasp, flexible tooth-borne partial denture framework, single cast partial dentures, temporary crowns and bridges, provisional crowns and bridges, occlusal appliances, implant abutments, orthodontic and sleep apnea appliances (Pfeiffer and Rosenbauer, 2004).

Hypoallergenic Resins  
These resin materials act as a substitute for polymethyl methacrylate in allergic patients. PMMA has higher water solubility than terephthalate based resin such as promysan, thermoplastic. PMMA is substituted by the light activated indirect composite containing methane dimethacrylate (UDMA) for the patients prone to hypersensitivity (Ganapathy et al., 2020).

Reinforced Resins  
High impacted resins  
Rubber particles are transferred into MMA to strengthen bonding ability with PMMA. Due to the greater impact strength, shows the patients having the frequent loose in dentures for example in parkinsonism, senility. They are available as a powder-liquid system & processing is the same as heat cure resins (Ángel Serrano-Aroca and Llorens-Gámez, 2017).

Fiber reinforced resins  
Due to low impact strength and fatigue resistance, the major problem is associated with PMMA Due to the combined effect of fatigue and impact strength causing maxillary fractures, whereas the mandibular fractures caused by impact strength.

Especially in the maxilla, the midline fractures are most common if there a proper bonding, fiber reinforcement shows 1000% increase in strength than non-reinforced (Ellakwa et al., 2008).

Metal Fiber Reinforced  
Metal fibres had a property of unaesthetic and also adhesion was very poor between the wire and acrylic resin and also expensive. The metal is also much prone to the corrosion, because of these disadvantages these materials have not been used in procedures of dentistry (Mohamed, 2004).

Carbon / Graphite Fiber Reinforced  
Carbon fibers (65-70 mm length, 5 % by weight) during packing the silane coupling agents placed were tested (Pesci-Bardon et al., 2006), these have a property of anisotropic that gives greatest reinforcement in denture base resins. The availability of carbon graphite fibers are chopped, woven, braided & tubular provides a more even distribution of reinforcement, high filler loading & easy handling because of fiber bundles. It increases flexural strength, impact strength will strengthen the resin (Fan, 2011).

Disadvantages  
This material shows poor aesthetic property by the formation of the black colour but that can be compensated by an opaquer. It may lead to a weakening of the finished prosthesis and the polishing of the material is very difficult (Gjorgievska et al., 2013). In adding to this lateral spreading of fibres during pressing is a major disadvantage.

Aramid Fiber Reinforced  
Aramid Fiber reinforced material has a property of increasing the strength of the prosthesis but it also possesses unaesthetic and also it is very strenuous to polish, so that it is used mostly for posteriors in which the areas where aesthetics are not very much salient.

Polyethylene Fiber Reinforced  
Multi fiber polyethylene strands are reduced to 65 mm length and for adhesion improvement surface is examined with epoxy-resin (to improve adhesion) and are placed in the resin during packing (Phoenix, 2004). Due to the increase in strength and stiffness in unidirectional, it develops anisotropic property (Yadav and Elkawash, 2011).

Advantages  
This material shows the greatest aesthetic property that means almost invisible in nature and also greatest impact strength and modulus of elasticity. It also shows the insignificant increase in case of flexural property (Castro and De, 2016).

It also shows a decrease in transverse strength but it may increase with an increase in polyethylene fiber reinforcement is done Triad VLC present for exam-
ple in implant-supported prosthesis resin (Keenan et al., 2003).

Disadvantages
Placement and finishing are difficult as fibers tend to protrude outside the mold. Moreover, polyethylene (even with plasma) does not bond (Ariga, 2018).

Glass Fibres
The denture base stability can be increased and stress transfer can be reduced by adding glass fibers (Jyothi, 2017; Duraisamy, 2019). 6 mm chopped glass fibers with 5% fiber in combination with injection molding technique will result in an increase in transverse strength, elastic modulus & impact strength (Selvan and Ganapathy, 2016). The plasma polymerization technique using HEMA, EDA is used to modify Glass fibers. The discrepancy of denture base resins are marginal yet severely affects the long term success of all ceramic complete veneer crowns (Ganapathy, 2016).

Advantages
These materials have the best aesthetic property and it is the excellent option for making denture base. These have excellent flexural properties, fatigue resistance and also the property of polishing. These materials can have an ability of resisting extremely high temperature, moisture and oil. In future to this natural substitutes can be tested (Subasree et al., 2016).

E-glass Fibers
Computer impregnated with a PMMA (porous polymer) and silane coupler that allows dissolution bonding to acrylic is known as E-glass. (e.g. Preat Perma Fiber) (Jain et al., 2017).

Advantages
There are two forms (mesh & fiber) and are translucent providing aesthetics. Due to glass fiber bonding, they also have more strength. (Vijayalakshmi and Ganapathy, 2016).

CONCLUSION
The various functional modifications and advancements in denture base resins have provided supporting results in dentistry. In its advancements, it has rectified the various problems and disadvantages caused by polymethyl methacrylate to the patients. In Future, many more advancements and modifications are required to provide better treatment and care to the patients oral health.

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Authors Contribution
The authors have carried out the study by collecting data from search engines and drafted the manuscript by necessary information. They have aided in the conception of the topic, have participated in the review, and have supervised in preparation of the manuscript. The authors have participated in the study design and have coordinated in developing the manuscript. All authors have discussed the study details among themselves and contribute to the final manuscript.

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