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Evaluation of flexural strength of denture base repaired by various materials and techniques

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***Abstract*---**Traditionally complete and partial dentures are desired form of replacement for missing teeth. A variety of polymers are used for different clinical procedures in dentistry, among these polymethyl methacrylate (PMMA) is most commonly used in dental settings. But in clinical practice, cracking and fracturing of the PMMA is the frequent cause of failure of complete or partial removable dentures. Thus a good material for repair must be chosen to overcome this problem. To evaluate the flexural strength of acrylic resin repair processed by different methods. An in-vitro study was conducted with Thirty-six maxillary denture bases prepared in the Laboratory at the Department of Prosthodontics and Crown & Bridge, at AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore. Ethical clearance was obtained from the institutional ethical committee, to conduct this study. This study was conducted on maxillary denture bases reinforced with various materials to assess the change in midline flexural strength of the denture base. For the study 36 maxillary denture bases were fabricated and divided into three groups depending on the material were made. Group 1 Auto polymerizing resin (DPI-RR), Group 2 High impact resin (Trevalon-Dentsply), Group 3 Glass fiber reinforced resin (Acralyn-H). Every group was further subdivided into Subgroup A with 6 round joints & Subgroup B with 6 butt joints. Statistical Analysis was done by using Statistical Package for social science (SPSS, IBM version 20.0). The level of significance was fixed at 5% and $p<0.05$ was considered statistically significant. Kolmogorov-Smirnov test and Shapiro-Wilk test were employed to test

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the normality of the data. Analysis of variance test, post hoc analysis, and student t-test was performed for quantitative variables. A comparative evaluation of the flexural strength of the denture bases revealed; a significant difference between the three groups (p-value .001) with significantly higher flexural strength in group 3 as compared to the rest two groups. Post hoc analysis also revealed significant differences between all the three groups when a between-group comparison was done. A comparative evaluation revealed a significant difference in both the preparations in group A and Group C with significantly higher strength in round joint preparation when compared with butt joint preparation. Under the due limits of the current study, the results concluded that denture bases repaired with reinforced glass fiber and round joints made in the fracture line had increased flexural strength when correlated with denture bases not reinforced with materials. Amongst the two joints used round joint had the highest flexural strength values as compared to the tooth butt joints used.

***Keywords*---**flexural strength, complete denture, resins, polymethyl methacrylate.

Introduction

Traditionally complete and partial dentures are desired form of replacement of missing teeth.[1,2] A definitive denture base material must have the following key properties; biocompatibility, good quality of esthetics, good bond potency with artificial teeth, radiopacity, effortless repair, and should have enough physical and mechanical assets.[3,4] These days a variety of polymers are used for different clinical procedures in dentistry[5-7]among these, polymethyl methacrylate (PMMA) is most commonly used in dental settings to make orthodontic retainers, dentures and their repair, relining, temporary crowns and, and manufacture of artificial teeth.[8-10]

PMMA, the resin was introduced by Dr. Walter Wright in 1937, and ever since it is a favorable choice of material in denture fabrication.[11] It has multiple advantages such as ease of processing, low cost, biocompatibility, precise shape, steadiness in the oral environment, adequate strength, the better quality of aesthetics, and construction of denture bases by simple processing techniques. But in clinical practice, cracking and fracturing of the PMMA is the frequent cause of failure of complete or partial removable dentures. [12,13] Most denture fractures occur within the mouth during masticatory functions. Stress escalation, unsupported denture base due to excessive ridge resorption, deep incisal notching at the labial frenum, jagged contour at denture base, deep cuts, and processing stresses are some factors that are responsible for denture fracture.[14]

The maxillary denture tends to fracture mostly through the midline due to tensile stress generated from masticatory forces. Management of these forces in the oral cavity is imperative for enduring success of denture prosthesis.[15-17] The choice of the dental prosthesis is predisposed by several factors such as aesthetic

prospects, expenditure, and patient satisfactoriness.[18] As per Eklund and Caplan D, high risk of edentulism associated with lower levels of education and income status[19,20] and complete and removable partial dentures are preferred choices of their treatment due to their easy affordability and user-friendliness.[18] Therefore; denture base repair ought to have the following properties; enough strength, cost-effective, easy to application, dimensional precision, and color matching.[21] There are several materials introduced to repair denture base like; heat-polymerizing acrylic (HPA) resin, auto-polymerizing acrylic (APA) resins, and light-polymerizing acrylic (LPA) resins.[22] Researchers also prove that fracture resistance of denture base increased by incorporating various reinforcing agents like glass fiber[23], carbon fiber[24], metal mesh[25], and polyethylene fibers.[26] Hence, the comparative evaluation of flexural strength of Auto polymerizing resin (DPI-RR), High impact resin (Trevalon-Dentsply) and, Glass fiber reinforced resin (Acralyn-H) needs further investigation. Therefore; the present study was conducted with maxillary denture bases fabricated by three different materials; Auto polymerizing resin (DPI-RR), High impact resin (Trevalon-Dentsply) and, Glass fiber reinforced resin (Acralyn-H) and modifying joint designs. The flexural strength was evaluated and compared.

Methodology

An in-vitro study was conducted with Thirty-six maxillary denture bases prepared in the Laboratory at the Department of Prosthodontics and Crown & Bridge, at AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore. Ethical clearance was obtained from the Institutional ethical committee, to conduct this study. This study was conducted on maxillary denture bases reinforced with various materials to assess the change in midline flexural strength of the denture base. For the study 36 maxillary denture bases were fabricated and divided into three groups depending on the material were made.

- Group 1 Auto polymerizing resin (DPI-RR)
- Group 2 High impact resin (Trevalon-Dentsply)
- Group3 Glass fiber reinforced resin (Acralyn-H)
- Every group was further subdivided into:
- Subgroup A with 6 round joints
- Subgroup B with 6 butt joints

Inclusion criteria

- Maxillary Heat cure acrylic denture base
- 2.5mm thickness of the Maxillary denture base
- The width of the gap created should be 3mm

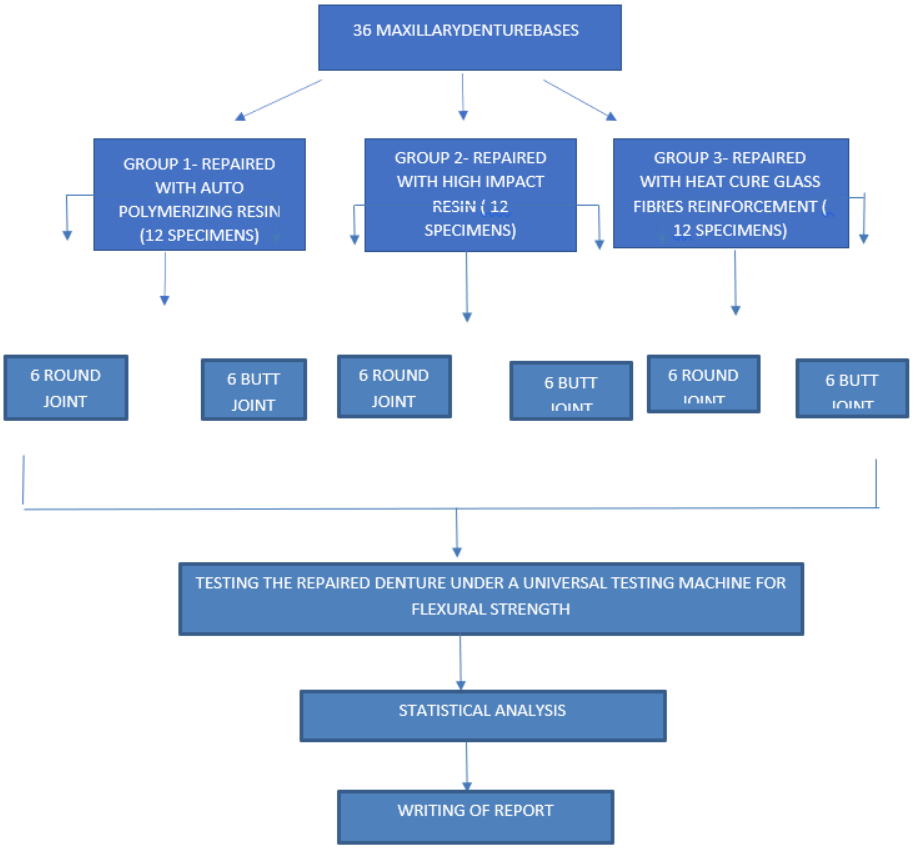
Exclusion criteria

The maxillary denture base containing internal or external porosities.

Material used

- Dental stone (Goldstone, India)
- Dental plaster (White gold, India)
- Modeling wax (Hindustan modeling wax, Hyderabad)
- Irreversible hydro colloid Impression material (DENTSPLY, Zelgan Plus)
- Digital Measuring gauge (InSize, Maharashtra)
- Universal testing machine (Zwick Roell)
- Self-cure material (DPI-RR Cold Cure TM, Dental products of India Ltd., Batch No 11204) (Figure 2)
- Heat cure material (Trevalon DENTSPLY) (Figure 2)
- Acralyn H (Asian acrylates Mumbai) (Figure 3)
- Vibrator (vibrator R2, Degussa)
- Acryliser

Study design



Fabrication of Denture Bases

Modeling wax was used to fabricate wax patterns for the denture base, and the thickness kept was 2.5mm. The above made wax pattern was then flasked with a Type-II Gypsum product. After the plaster was set separating media was applied. The water bath having boiling water is used as a medium for dewaxing. A layer of cold mold seal was applied on to the cast, plaster area as well as mold area when the flask was warm. The packing procedure was started after the cooling of the flasks. A ratio of 3:1 by volume was used for polymer and monomer of polymethyl methacrylate. Stringy stage is considered to ensure repairing material in the mid-palatine area and mold was packed as soon as it reached the dough stage. A hydraulic press was used to secure the flask. The short curing cycle was used for acrylization. The electrical acryliser was used to keep the flask at a temperature of 74°C for 1½hrs followed by 100°C for 30minutes.The procedure of bench curing for 8hrs was followed once the flask was removed from the acryliser. The deflasking of the denture base was done followed by gross trimming of the denture base. The denture bases with no porosity were accepted. A digital measuring gauge was used to measure the thickness of denture base. The same technique was followed for all the Thirty-six denture bases fabricated.

Testing of Denture base under Universal testing machine: The denture bases were checked under a Universal testing machine to calculate the value of flexural strength. The base was kept in such a way that the intaglio surface up and `facing the round fixture of the Universal testing machine. The center of the mid-palatine area adjoining the second premolar and the molar area is taken into account for the application of force. Over all thirty-six denture bases were checked in the same way and the results were estimated.

Statistical analysis

The data collected was entered in Microsoft Excel and subjected to statistical analysis using Statistical Package for social science (SPSS, IBM version 20.0). The level of significance was fixed at 5% and $p<0.05$ was considered statistically significant. Kolmogorov-Smirnov test and Shapiro-Wilk test were employed to test the normality of the data. Analysis of variance test, post hoc analysis, and student t-test was performed for quantitative variables.

Figures:

Figure 1. Wax pattern

Figure 2. Pattern fabricated

Figure 3. All the specimens stored in distilled water

Figure 4. Fractured sample

Results

To evaluate the flexural strength of acrylic resin repair processed by different methods, Thirty-six heat cure resin denture bases were made for maxilla, which was divided into three groups. Each group had 12 samples which were further divided into two subgroups based on various types of materials used. The control group was auto polymerizing resin, and the experimental groups were high impact resin, and glass fiber reinforced resin material. The two subgroups were

divided into butt joints and round joints. The results are based on an analysis of 36 samples evaluating and comparing the flexural strength between the three groups and two subgroups.

Table 1 shows the evaluation of the flexural strength of three different denture bases. An evaluation revealed higher mean flexural strength in Group 3 (56.30±2.49) when compared with the other two groups. Table 2 - A comparative evaluation of the flexural strength of the denture bases revealed a significant difference between the three groups (p-value .001) with significantly higher flexural strength in group 3 as compared to the rest two groups Post hoc analysis revealed significant differences between all the three groups when a between-group comparison was done. Graph 2 shows the evaluation and comparison of the flexural strength containing round joint preparation. A comparative evaluation revealed significantly higher strength (p-value .001) in Group 3. Post hoc analysis revealed significant differences when a between-group comparison was done. Table 3 shows the evaluation and comparison of flexural strength using different preparation. A comparative evaluation revealed a significant difference in both the preparations in group A and Group C with significantly higher strength in round joint preparation when compared with butt joint preparation. No significant difference was found between groups B for both preparations. Graph 3 shows the evaluation and comparison of flexural strength using different preparation. A comparative evaluation revealed a significant difference in both the preparations in group A and Group C with significantly higher strength in round joint preparation when compared with butt joint preparation. No significant difference was found between group B for both preparations.

Discussion

Mid-line fractures of dentures are very often while functioning which may affect the underlying soft structures and leads to resorption of the enduring alveolar ridge. The present study was conducted to evaluate the flexural strength of acrylic resin, repair processed by three different methods. For this, 36 maxillary denture bases were fabricated and repaired by Auto polymerizing resin (DPI-RR), High impact resin (Trevalon-Dentsply) and Glass fiber reinforced resin (Acralyn-H), than flexural strength was compared. A similar study was conducted by AlQahtani M et.al., Forty rectangular shaped (50 mm, 25 mm, 3 mm) PMMA specimens were fabricated and repaired with HPA, APA, and LPA resins, respectively than subjected to a three-point flexural test. [27]

In this study, a comparative evaluation of the flexural strength of the denture bases revealed a significant difference between the three groups (p-value .001) with significantly higher flexural strength in group 3 (Repair with glass fiber reinforced heat cure resin-Trevalon-Dentsply) as compared to the rest two groups. A study conducted by Golbidi F et.al., found the specimens repaired by Meliodent auto-polymerizing acryl and fiberglass had high flexural strength (126 MPa), as compared with the specimens repaired with Acropars auto-polymerizing acryl without fiberglass (76.2 MPa).[28] Singh K et.al., conducted a study to evaluate and measure the flexural strength of heat polymerized PMMA after reinforcement with nylon fibers and glass fibers, they found that fibers significantly affected the

flexural strength of PMMA. Polymers, reinforced with glass fibers had a positive outcome on the fracture resistance of dentures.[29] Strengthening of resins with glass fibers is a striking choice to enhance the mechanical properties, and it has another advantage also; if the prosthesis fractures appallingly, fractured portions are likely held together by the fibers as per a study by Singh K et.al. Similar results were found by John et al in their study.[23] According to Vallittu et al [30] usages of 5% GF increase the transverse strength up to 38%. To increase potency Osberone used wires, nylon, and glass fibers as strengtheners and he found glass fibers are the best strengtheners.[31]

A comparative evaluation revealed a significant difference in both the preparations in group A and Group C with significantly higher strength in round joint preparation when compared with butt joint preparation. No significant difference was found between group B for both preparations. A comparative evaluation revealed a significant difference in both the preparations in group A and Group C with significantly higher strength in round joint preparation when compared with butt joint preparation. No significant difference was found between group B for both preparations. Almost similar results were found by Harrison WM et.al., he used three types of joint contours, viz., round joint, rabbet joint, and butt joint, and concluded that that the rounded joint had better to the rabbet and butt joints because it distributed all stress uniformly.[32]

In contrast to this study, H Mahajan et.al., Original specimens were higher transverse strength as compared with repaired specimens. Preparations made with a round joint were higher was higher in Transverse strength than butt and rabbet joint.[33] The fracture of Poly Methyl Methacrylate denture base is an unrelenting clinical problem that prosthodontists are facing. For this, the repair of the denture base is a provisional or for the situation, a few a permanent solution. Therefore repair methods should be easy, cost-effective, and ensure adequate strength against fracture during functioning.

Conclusion

Under the due limits of the current study, the results concluded that denture bases reinforced with glass fiber and round joints made in the fracture line had increased flexural strength when correlated with denture bases not reinforced with materials. Amongst the two joints used round joint had the highest flexural strength values as compared to the tooth butt joints used. Chemical polymerization showed lesser flexural strength values as compared to the warm water bath technique. Further researches to simplify the repair process is required.

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