EVALUATION OF FLEXURAL STRENGTH AND CANDIDA ALBICANS ADHESION OF AN ACRYLIC RESIN REPAIRED WITH 4 DIFFERENT RESIN MATERIALS

ABSTRACT

Background and Aim: This study aims to investigate adhesion of Candida albicans and flexural strength of an acrylic resin repaired with 4 different acrylic materials.

Materials and Methods: One hundred heat polymerizing acrylic specimens (60x20x3mm) were prepared from a negative mold of a metal master model. After obtaining silicone indexes the specimens were cut into two equal parts with a saw (Isomet 4000, Buehler Ltd., Lake Bluff, IL). Four different materials light-polymerizing (LP), autopolymerizing (AP), heat polymerizing (HP) or microwave polymerizing (MP) acrylic resins were used to repair the denture material. Fifty of the specimens were then contaminated with Candida albicans culture. Three point bending test was used to determine flexural strengths of materials. The data were analyzed with One-way ANOVA and Tukey statistical tests at 0.05 significance level.

Results: Light polymerizing acrylic resin represented the highest colony number values (49.3±6.2) and this value was significantly higher compared with the colony number values of HP, MP and control groups (p=0.01). MP and HP resins exhibited statistically similar microbial colony numbers (p=0.84). Heat polymerizing acrylic resin exhibited the highest flexural strength value (45.43±3.2) in all test groups. Number of adhesive fracture was significantly higher (9/10) in LP group than the other groups.

Conclusion: The repairing materials tested were highly susceptible to Candida albicans adhesion and flexural strengths of these materials were not satisfactory in prosthodontic practice.

Key words: Candida Albicans, Denture Repair, Flexural Strength, Fracture Types, Repair Materials
**INTRODUCTION**

Candida albicans, the abundant Candida species, is a commensal organism in the oral cavity. Surface roughness, the most frequently discussed mechanical property can change the microbial adherence on the denture base materials. For this reason the selection of the repairing material becomes prominent since Candida albicans can easily adhere not only to mucous surfaces but also the acrylic denture materials.

Polymethyl methacrylate base material is used for fabricating complete and partial removable dentures. However, this material has some limitations about the mechanical properties such as surface roughness, color difference, bending strength etc., which still demonstrate some clinical difficulties in prostodontic practice. Particularly midline fractures and cracks are the most seen problems of denture bases during function which have to be renewed or repaired.

Repairing the fractured or cracked denture is usually a better way than fabricating a new one. To restore the original shape and strength there are several repair resins available with enhanced laboratory and clinical properties. Heat polymerizing acrylic resin materials have higher mechanical properties when compared with light, auto or microwave polymerizing acrylic resins, however they need complicated and time consuming process. Owing to the faster procedure and ease of use, auto, light or microwave polymerizing acrylic resins are widely used clinically; nevertheless their deficit about surface irregularities are discussed by several researchers.

The adhesion phenomenon at the repair side defines the success. Resistance to refractures and color changes should be the aim of this repair process. Specifying the fracture type may ensure us to understand this phenomenon. Fractured or cracked dentures can be repaired with light-polymerizing (LP), autopolymerizing (AP), heat polymerizing (HP) or microwave polymerizing (MP) acrylic resins. The choice depends on the strength, color, dimensional stability manipulation technique and clinical factors of the material. However, there is limited research about Candida albicans adhesion on repaired denture base resin surfaces and a few of them determined the fracture types.

The aim of this study was to evaluate (i) the adherence potential of Candida albicans on the denture base surface, repaired by light-polymerizing, autopolymerizing, heat polymerizing or microwave polymerizing acrylic resins and also (ii) to examine the flexural strengths and fracture types of the repairing materials.

**MATERIALS AND METHODS**

**Specimen preparation**

A total of 100 acrylic resin specimens including control group (n: 20) were prepared in the dimensions of 60x20x3 mm. A master metal model was used for obtaining negative space from a high viscosity silicone impression material (3M ESPE Dental Products, Seefeld, Germany). The wax patterns were fabricated using silicone indexes and then embedded into a dental stone (Herodont Soli Rock, Rio de Janeiro, Brasil) in a metal flask. A heat polymerizing acrylic resin (QC 20, Densply Ind. Com. Ltd, Petropolis, RJ, Brasil) was mixed for 60 s with a ratio of 23g/10 ml powder/liquid according to manufacturer’s recommendations. The acrylic resin was packed into dental stone mold at the dough stage 12-15 minutes after mixing. The metal flasks were then closed, and polymerization process was performed according to manufacturer’s recommendations.

All flasks were allowed to cool for 3 hours at room temperature and then opened. The excess resin was removed with a bur (KG Sorensen, Barueri, SP, Brasil). Aluminium oxide papers of 320, 400 and 600 grid smoothers were sequentially used for finishing. After polishing with a paste (Composite Polish; Ultradent Products Inc, South Jordan, Utah), the specimens were ultrasonically cleaned (Ultrasonic Cleaner, model 2840 D) and then immersed in distilled water at 37°C for 48±2 hours.

**Creating fracture and repairing procedure**

The specimens were embedded into lower part of metal flasks filled with additional silicone impression materials to form a silicone index. A specially designed holder was used in order to cut the specimens into two equal halves using a saw (Isomet 4000, Buehler Ltd., Lake Bluff, IL). Irregularities of the cut-ends were grounded with a bur (KG Sorensen, Barueri, SP, Brasil) forming 3 mm gap between halves and then finished with a 600 grid sand paper. Specimens were then immersed in distilled water for 48 hours after 20 minutes ultrasonic cleaning.

All cutting surfaces were wetted with the monomer for 180 s and air blasted for 30 s. Then the halves were settled into their initial positions of the silicone index (Figure 1). The gap was filled with acrylic resin that was prepared according to manufacturers’ recommendations. Twenty
specimens were repaired in each group (total: 80). Four different repairing materials were used: a heat polymerizing acrylic resin (QC 20, Dentsply Ind. Com. Ltd, Petropolis, RJ, Brasil), a microwave polymerizing acrylic resin (Acron, GC America Inc., Alsip, IL, USA), an autopolymerizing acrylic resin (Meliodent SC, Heraus Kulzer Ltd, Newbury, UK) and a light polymerizing acrylic resin (Triad, Dentsply York Division, USA). After polymerization the specimens were again finished and polished by performing the same procedures and ultrasonically cleaned for 20 minutes.

**Contamination Process**

All the specimens were sterilized with ethylene oxide gas (1 liter/3-4 h). Ten of the specimens in each group (total: 50) were then inoculated with Candida albicans (ATCC 18804) culture at 0.5 McFarland scale which corresponds to 10⁸ colony forming units (cfu)/ml for 1 hour at 37°C. The specimens were rinsed for 15s with sterile distilled water and inoculated face down into the Sabouraud dextrose medium for 30 minutes. After removing the contaminated specimen, the mediums were incubated for 24 h at 37°C (Nüve, Ankara, TR). The numbers of Candida albicans colonies were then counted in each group with an image analysis program (BioImaging Systems UVP, Upland, CA).

**Flexural strength test**

The flexural properties were measured by using a universal testing machine (Lloyd LR 50K, Lloyd Ins. Ltd., West Sussex, UK). The non-contaminated 10 specimens of each group were supported on the jigs of a three point bending test with a diameter of 3 mm and span length 50 mm. The load was applied to the centre of the specimen at 0.5 mm/min crosshead-speed (maximum 5000 N) until the fracture occurred. The data were recorded using the software of the testing machine. The types of fractures were identified with light microscope (Leica, Wetlaird, Germany) under 4x magnifications and recorded as adhesive, cohesive or mix.

**Statistical analyses**

The data were statistically analyzed with One-way ANOVA at p<0.05 significance level. Tukey test was then performed to obtain the statistical differences among the test groups having different number of microbial colonies. P value less than 0.05 was considered significant.

**RESULTS**

The mean number of Candida albicans colonies was presented in Table 1. The mean and standard deviations of colony numbers were 49.3±6.2; 43.4±6.6; 33.2±3.9; 31.1±3.2 and 25.2±3.2 respectively for LP; AP; MP; HP and C groups. The highest colony numbers were observed on LP surfaces and the results were significantly different from HP, MP and C groups (p<0.01). There was no significant difference between LP and AP groups (p=0.073). The lowest colony numbers were counted in group C which was significantly different from LP, MP and AP (p<0.01). No significant differences was observed between C and HP groups (p=0.073). MP exhibited close-range microbiological counts to HP, and the mean values were not significantly different (p=0.84).

The flexural strength and fracture types of groups were presented in Table 1. The highest mean flexural strength value was obtained in HP group (45.43±3.2 N) and the lowest was in LP group (21.16±2.6 N). Adhesive fracture was the most common type within all the test groups. The highest number was obtained in group LP with the ratio of 9/10 and followed by AP, MP and HP with 7/10, 6/10 and 4/10, respectively. Mix and cohesive type fractures were rarely observed (Table 1).

**DISCUSSION**

This study investigated the adhesion potential of Candida albicans on heat polymerizing acrylic denture base material repaired with 4 different acrylic resins and also compared the flexural strengths of these materials. Candida albicans may return into complex structures, often encapsulated within a matrix of exopolymeric material that favors a strong adhesion to biotic and abiotic surfaces when the balance of normal oral microflora is disrupted. It is accepted that the repair of denture depends on many variables such as denture base resin combination, repair material, surface design and treatment or the technique used. Therefore, the microstructure and surface texture of the repair material never looks or functions like the denture base material even the same material is used. The
adhesion of the Candida is related with the existence of microporosity on the surface of the denture,13 and if such a condition occurs Candida species can easily proliferate. This is the primary reason that Candida albicans was selected for evaluation.

It was shown that LP groups generated the most suitable growth environment for Candida albicans. Composite materials of Visible Light Cure (VLC) resins, which are closer to light source, polymerizes first and during polymerization phase this phenomenon may produce gaps and porosities as a result of shrinkage over the surface area.14 Therefore the high colony numbers of LP group in present study may be due to the surface roughness of this repairing material. It is well known that microbial adherence is highly affected by surface roughness.8 Lewinstein et al.15 and Razavi et al.16 indicated that VLC acrylic resins can show similar mechanical properties like heat cure and autopolymerizing acrylic resins, on the contrary the results of this study exhibited that the lowest mean flexural strength value was in LP group.

Even though there are many ways for repairing, AP acrylic resins provide simple and quick application that it is still the most selected process to repair the fractured or cracked denture base materials. On the contrary, in this study flexural strength value of AP and LP groups decreased by about 58%, and mean number of colony value increased by 72% when compared with control. These failures may be explained by the chemical initiator’s local activity that reduces the conversion degree during the polymerization stage. This weakens the transfer strength of material and disrupts the surface structure.12,17 These statements were consistent with the results of current study that AP represented low flexural strength values, high adhesive failure rates and high colony numbers. Certain physical properties of MP acrylic resins like transfer strength, showed 93% to 106% of denture base material in previous studies.18,19 However according to the results of our study the mean flexural strength value of MP group was 43% lower than the control group. The highest flexural strength value was obtained in HP group with 80% of the base material.

Although the lower residual monomer content appeared to be an advantage of MP acrylic resin,19 it is rarely used for denture repairs. Fernanda et al.20 demonstrated that microwave acrylic resins represented irregular surface patterns when compared to a heat polymerizing acrylic resin. This might explain why the colony numbers of MP group was higher than that of HP in our study. However, the difference was not significant at 0.05 confidence level. To enhance the reliability of the experiment the specimens were separated into two equal halves by a saw rather than fracturing it mechanically in order not to form cracks and not to alter the flexural test data.21 According to Seo et al.12 the repair gap between the seperated parts was ranging from 1.5 to 3 mm. The gap was not wider than 3 mm in order to prevent pure cohesive fracture in the present study.22 On account of determining the flexural strength values, three point bending test was used. Bural et al.23 have shown that flexural strength of repair materials for respect to denture base was within a wide percentage range (18% to 95%). In this study this range was between 32% and 70%. Although Rodrigo et al.24 observed that mix type fracture was ranging from 33% to 100%, in the current study mix type fracture was recorded only up to 40%, and moreover adhesive type fractures were common, ranging from 40% to 90% while cohesive fractures were 0 to 20%. This variety may be due to the different structures of materials and the techniques used as previously mentioned. Within the limitations of this study, we evaluated 4 different repair methods in vitro. The flexural test conditions were not similar to that of oral cavity and no aging procedure was

### Table 1. Mean colony numbers, flexural strength and fractures types of test groups.

<table>
<thead>
<tr>
<th></th>
<th>Heat polymerized</th>
<th>Light polymerized</th>
<th>Microwave polymerized</th>
<th>Auto polymerized</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colony numbers (Mean ± SD)</td>
<td>31.1±3.2 a</td>
<td>49.3±6.2 b</td>
<td>33.2±3.9 a</td>
<td>43.4±6.6 b</td>
<td>25.2±3.2 a</td>
</tr>
<tr>
<td>Flexural strength (N, Mean ± SD)</td>
<td>45.43±3.2 x</td>
<td>21.16±2.6 y</td>
<td>37.15±2.7 x</td>
<td>27.28±3.8 y</td>
<td>64.27±4.3 z</td>
</tr>
<tr>
<td>Types of fractures</td>
<td>4 adhesive 2 cohesive 4 mix</td>
<td>9 adhesive 1 mix</td>
<td>6 adhesive 1 cohesive 3 mix</td>
<td>7 adhesive 1 cohesive 2 mix</td>
<td></td>
</tr>
</tbody>
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Same letters with no statistical significant differences
performed. On the other hand the oral environment consists of several microorganisms, not only Candida albicans. In the future studies, at better simulated conditions varied microorganisms even biofilm formations should be evaluated.

CONCLUSION

Within the limitations of this study the following statements are concluded:

1. LP acrylic resin exhibited the most suitable environment for Candida albicans generation.
2. Adhesive type fractures pointed out that none of the repair methods were resistant enough for flexural tests when compared with denture base material.

REFERENCES