ORIGINAL RESEARCH

Influence of Three Different Denture Cleansers on Surface Roughness and Strength of Heat-polymerizing Resin: An *In Vitro* Study

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Abstract

Aim: The purpose of the current study was to evaluate the impact of three different denture cleansers on the strength and surface roughness of heat-polymerizing resin.

Materials and methods: A total of 120 resin discs (10 mm in diameter and 2 mm thick) were created using a stainless steel mold for surface roughness testing and flexural strength testing (in accordance with the American Dental Association (ADA) Specification No.12). Samples were divided into one of three groups (40 samples in each group): group I: Clanden, group II: Clinsodent, group III: Fittydent. Samples were immersed in denture-cleansing solutions for 30 minutes every day, and this process was repeated over a period of 15 days. Samples were stored in distilled water at room temperature in between the immersions. A surface analyzer was utilized to compare the surface roughness of each sample before and after immersion treatments. For recording flexural strength, each sample was subjected to three-point bending test by mounting samples on Universal testing machine. Comparing mean values between groups using one-way ANOVA and the Tukeys honest significant difference (HSD) *post hoc* test. A significance level of 0.05 was used for all statistical calculations

Results: After 15 days, the maximum change of mean surface roughness of heat-polymerizing resin was found in Clanden denture cleanser group (2.64 ± 0.12) followed by Clinsodent group (2.26 ± 0.09) and Fittydent group (1.92 ± 0.06). After 15 days, the maximum change of mean flexural strength changes of heat-polymerizing resin was found in Clanden denture cleanser group (94.78 ± 0.14), followed by Fittydent group (98.64 ± 0.03) and Clinsodent group (99.26 ± 0.21).

Conclusion: Within the limitation, the current study concluded that changes were observed in surface roughness and flexural strength of all heat-polymerizing resin samples after immersion in all three denture cleansers; but least surface roughness and flexural strength changes were observed with the Fittydent cleanser group and Clinsodent group, respectively.

Clinical significance: Cleaning dentures is crucial for maintaining both the prosthesis and oral health; therefore, it is necessary to select a cleanser that is effective without negatively affecting the base resin's qualities over time.

Keywords: Denture cleansers, Flexural strength, Heat-polymerizing resin, Surface roughness.

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Introduction

The rate of total and partial edentulism is increasing along with aging. As a result, among elderly persons who frequently wear dentures, the use of removable prosthesis has increased. Edentulism has an impact on the patient's oral health and overall health. Denture placement causes significant changes in the oral environment and has a negative impact on the health of the oral tissues. The patient has difficulty chewing and oral lesions associated with dentures, such as angular cheilitis, traumatic ulcers, and denture stomatitis.[1]

For denture disinfection, several different methods have been suggested. The removal of biofilm from denture surfaces is frequently accomplished mechanically by using dentifrice brushing or ultrasonic cleaning. Immersion in chemical cleansers should be utilized in conjunction with mechanical procedures whenever there is a lack of motor coordination, notably in elderly patients who make up the bulk of denture wearers.[2] Alkaline peroxides, acids, disinfectants, and enzymes can all be used to clean dentures. They ought to successfully destroy bacteria without harming the surface of the denture material.[3]

Denture cleansers should ideally lessen or eliminate biofilm without changing the denture base material's physical and

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mechanical characteristics. However, according to a number of studies, the prolonged use of denture cleansers can produce destructive undesirable effects on the physical and mechanical properties, including the surface roughness, color, and hardness of denture base resins.[4] Surface roughness plays a significant role in the development of plaque and bacterial colonization on dentures. The ease of finishing and polishing as well as the resistance to erosion during cleaning depend on the physical strength of the denture base resin.[5]

Due to its outstanding esthetic, appropriate physical qualities, affordable price, and simple production method, polymethyl methacrylate (PMMA) resin has a long history of being used as the basic material for dentures. However, the biggest drawbacks that limit the clinical effectiveness of PMMA prosthesis are dimensional errors, microbial adherence, poor mechanical qualities, and allergic adverse effects. Understanding how the characteristics of the PMMA denture foundation are affected by frequently used oral hygiene products is crucial.[6]

Denture cleansers may be more harmful to the prosthesis than beneficial if they alter the denture base resin's physical characteristics, such as strength or surface roughness. Thus, selecting the right cleansers is crucial. Hence, the current study was conducted to evaluate the impact of three different denture cleansers on the strength and surface roughness of heat-polymerizing resin.

Materials and Methods

Fabrication of Samples

The present study was conducted in the department of Prosthodontics, Krishnadevaraya College of Dental Sciences, Bengaluru. A total of 120 resin discs (10 mm in diameter and 2 mm thick) were created using a stainless steel mould and then invested in type III gypsum material in a metallic flask for use in assessing surface roughness and flexural strength (in accordance with the American Dental Association (ADA) Specification No. 12). Dewaxing was done after the stone was set, and then separating media was applied. Molds were packed with heat-polymerized acrylic resin (DPI Heat Cure, India) and processed in accordance with the manufacturer's instructions. The heat-cured resin underwent a brief curing cycle for acrylization that consisted of 60 minutes at 70°C and 30 minutes at 90°C. The process was repeated to create the total of 120 resin discs for the present study. The samples were taken out of the molds, trimmed with a tungsten steel bur mounted in a handpiece at a low speed, finished with 120, 220, and 320-grit sandpaper, then polished with a damp cloth and pumice slurry. All samples had their dimensions measured using a digital Vernier caliper, and those that were not exact had to be changed out for fresh ones. To remove any remaining monomer, all samples were then submerged in distilled water at 37°C for 24 hours.

Immersion Procedure

A total of 40 samples were assigned to one of the following groups (20 samples for surface roughness and 20 samples for flexural strength in each group):

Group I: Clanden – One 480 mg tablet (Global Pvt Ltd, India) was diluted in 50 mL of warm water, with a three-minute immersion duration.

Group II: Clinsodent – One 480 mg tablet (ICPA Health Products Ltd, India) was dissolved in 50 mL of warm water, and the immersion period was 30 minutes.

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Conflict of interest: None

Group III: Fittydent: One tablet (Dr. Reddy's Laboratories Ltd., India) diluted in 50 mL of warm water with a 10-minute immersion time.

The samples were distributed at random and submerged in denture cleansers-filled beakers. In order to ensure that the solution covered each sample, each one was submerged such that the surface to be tested faced upward. The denture-cleansing solutions were produced in accordance with the manufacturer's instructions, and after the recommended amount of immersion time completes, the resin samples were removed and thoroughly washed under running water before being dried with absorbent paper. Samples were immersed in denture-cleansing solutions for 30 minutes every day and this process was repeated over a period of 15 days. Samples were stored in distilled water at room temperature in between the immersions.

Evaluation of Surface Roughness

A surface analyzer was utilized to compare the surface roughness of each sample before and after immersion procedures. With the use of a stylus, three lines were recorded with a 1 mm gap between them, and the mean arithmetic roughness Ra was computed. To access surface changes, the Ra was utilized. While "ΔRa" stood for the difference in roughness measurements made before and after samples were submerged in denture cleansers.

Evaluation of Flexural Strength

Samples were mounted on a universal testing machine (Instron, India) and loaded with 50 kgf (Kilogram-force) at a crosshead speed of 5 mm/minute to evaluate the flexural strength of the material. Flexural strength measurements were made for 10 samples in each group before immersion and remaining samples were measured after submerged in denture cleansers. Each specimen's flexural strength (S) was determined using the following formula:

$$S = 3PL/2BD^2$$

where L = distance between supports (50 mm), S = flexural strength (MPa), P = peak load, B = specimen width (10 mm), and D = specimen thickness (2.5 mm).

Statistical Analysis

The statistical program SPSS version 20 was used to analyze the data. Comparing mean values between groups using one-way ANOVA and the Tukeys Honest Significant Difference (HSD) *post hoc* test. A significance level of 0.05 was used for all statistical calculations.

Results

Table 1 presents the surface roughness of heat-polymerizing resin before immersion into different denture cleansers. The mean surface roughness of heat-polymerizing resin in Clanden denture cleanser group was 1.20 ± 0.04, in Clinsodent group, it was 1.18 ± 0.10, and in Fittydent group, it was 1.22 ± 0.0. There was no statistically significant difference between the groups.

Table 2 depicts the surface roughness of heat-polymerizing resin after immersion into different denture cleansers. The

Table 1: Evaluation of surface roughness of heat-polymerizing resin before immersion into different denture cleansers

Denture cleansers	*Surface roughness of heat-polymerizing resin (µm)*	*F value*	*p-value*
Group I: Clanden	1.20 ± 0.04	6.189	0.762
Group II: Clinsodent	1.18 ± 0.10		
Group III: Fittydent	1.22 ± 0.01		

Table 2: Evaluation of surface roughness changes of heat-polymerizing resin after immersion into different denture cleansers

Denture cleansers	*Surface roughness of heat-polymerizing resin (µm)*	*F value*	*p-value*
Group I: Clanden	2.64 ± 0.12	4.108	0.001
Group II: Clinsodent	2.26 ± 0.09		
Group III: Fittydent	1.92 ± 0.06		

Post hoc test: Clanden vs Fittydent – *p*-value – 0.001

Table 3: Evaluation of flexural strength of heat-polymerizing resin before immersion into different denture cleansers

Denture cleansers	*Flexural strength of heat-polymerizing resin (MPa)*	*F value*	*p-value*
Group I: Clanden	104.04 ± 0.16	10.243	0.938
Group II: Clinsodent	104.88 ± 0.01		
Group III: Fittydent	105.01 ± 0.06		

Table 4: Evaluation of flexural strength of heat-polymerizing resin after immersion into different denture cleansers

Denture cleansers	*Flexural strength of heat-polymerizing resin (MPa)*	*F value*	*p-value*
Group I: Clanden	94.78 ± 0.14	12.316	0.001
Group II: Clinsodent	99.26 ± 0.21		
Group III: Fittydent	98.64 ± 0.03		

Post hoc test: Clanden vs Clinsodent and Clanden vs Fittydent – *p*-value – 0.001

maximum mean surface roughness of heat-polymerizing resin was found in Clanden denture cleanser group (2.64 ± 0.12) followed by Clinsodent group (2.26 ± 0.09) and Fittydent group (1.92 ± 0.06). *Post hoc* test shows the statistically significant difference between Clanden vs Fittydent ($p < 0.001$).

The flexural strength of heat-polymerizing resin before immersion into different denture cleansers is given in Table 3. The mean flexural strength of heat-polymerizing resin in Clanden denture cleanser group was 104.04 ± 0.16, in Clinsodent group, it was 104.88 ± 0.01, and in Fittydent group, it was 105.01 ± 0.06. There was no statistically significant difference between the groups ($p > 0.001$).

The flexural strength of heat-polymerizing resin after immersion into different denture cleansers is depicted in Table 4. The maximum mean flexural strength changes of heat-polymerizing resin was found in Clanden denture cleanser group (94.78 ± 0.14), followed by Fittydent group (98.64 ± 0.03) and Clinsodent group (99.26 ± 0.21). *Post hoc* test shows the statistically significant difference between Clanden vs Clinsodent and Clanden vs Fittydent $p < 0.001$).

The inference of the study indicates that the least surface roughness changes was observed in Fittydent cleanser group and least flexural strength changes was observed in Clinsodent group.

Discussion

The surface of the acrylic base denture can influence the oral health profile of denture wearers. The poor surface texture of the acrylic foundation, which comes into direct contact with oral tissues, encourages the accumulation of bacteria. The surface texture of acrylic dentures is influenced by a variety of elements, including residual methyl methacrylate (MMA) monomer, polymerization techniques, polymerization cycles, water storage times, and denture washing procedures.[7] Due to porosity, the roughness profile has a strong correlation with remaining MMA monomer. Therefore, the samples were submerged in distilled water for a day before testing to lessen the amount of residual MMA monomer.

Any dental prosthesis' longevity is primarily based on how well it is cared for and kept clean, which in turn depends on how well the patient takes care of themselves at home. Inadequate denture washing causes food debris to build up and harbor germs and salivary mucus, which results in odor.[8] The most often used way for washing dentures is to soak them in any commercially available denture cleaning solution for the entire night. The acrylic resin in denture cleaning by immersion in chemical solution should preferably not undergo any physical, mechanical, or chemical changes. However, it has been shown that the surface morphology may change as a result of the cleaning procedure. The alkaline peroxide solution could change the characteristics of the resin; however, the effervescent pills are effective at removing biofilm and stains. Additionally, the rough surface of the dentures may shield the germs from both natural and oral hygiene procedure removal efforts.[9]

In the current study, the Fittydent group had the lowest mean surface roughness, which was followed by the Clinsodent group and the Clanden denture cleansers group. Similarly Yadav R et al.[10] and Sharma P et al.[7] stated that the The Fittydent denture cleaning tablet is a commercial denture cleaning product that contains sodium perborate as the major ingredient. Fittydent tablets are dissolved in water, they quickly break down into hydrogen peroxide (H_2O_2) and nascent oxygen (O), which when combined in aqueous solution, cleans surface dirt and stains by an effervescent action.

On the contrary, Rodrigues Garcia RC et al.[11] discovered that usage of sodium perborate cleansers increased surface roughness due of inability to remove pellicle generated on acrylic surface. Additionally, Ural C et al.[12] found no differences among commercial cleansers in terms of how they affected surface roughness.

Flexural fatigue of the denture is the main cause of clinical failure of the prosthesis. Because it produces stresses similar to those produced to the denture during mastication, the flexural three-point bending test is carried out on denture resin. Similarly, studies conducted by Grajower R and Goultschin J[13] and Harrison A and Huggett R[14] reveal that a small amount of PMMA monomer is left over after the polymerization reaction is finished. This monomer acts as a plasticizer, reducing the interchain forces and yield in early deformation under load, which lowers the flexural strength of denture base acrylics.

Among all the three denture cleansers used, Clinsodent group showed statistically minimal reduction in values of flexural

strength in comparison to other two groups. According to Smith LSA and Schmitz V,[15] polymerized acrylic resins have a tendency to constantly absorb water when submerged in an immersion medium for a prolonged time, which acts as a plasticizer and weakens the resin. Contrarily, Puri D et al.[16] reported that when submerged in Clinsodent as compared with all other groups, the values of surface roughness and flexural strength were higher.

The current study had some limitations, including the fact that only one type of denture base resin was used, the lack of accurate simulations of oral conditions, such as salivary composition and pH levels or the presence of biofilm, and the short study period despite the fact that denture cleansers can be used for much longer periods of time. Future *in vivo* research should investigate additional mechanical properties of heat-cure resins in order to get over this limitation.

Conclusion

Within the limitation, the present study concluded that the changes observed in surface roughness and flexural strength of all heat-polymerizing resin samples after immersion in all three denture cleansers; but least surface roughness and flexural strength changes were observed with the Fittydent cleanser group and Clinsodent group, respectively.

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