The effect of denture cleanser 48% sodium bicarbonate on surface roughness changes of heat-cured acrylic resin

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ABSTRACT The surface of heat-cured acrylic resin on the base of artificial teeth has a risk of surface roughness. Its causes are liquid absorption and chemical processes. Fluid absorption can be affected by immersion in denture cleaners containing sodium bicarbonate. This study aims to determine the effect of a denture cleanser containing 48% sodium bicarbonate on changes in heat-cured acrylic resin's roughness. This study used 16 specimens of heat-cured acrylic resin (brand Meliodent) and was square in size of 10x10x2.0 ± 0.5 mm. The samples' roughness is measured by using Atomic Force Microscopy (AFM). The specimens were immersed in denture cleaning tablets containing 48% sodium bicarbonate for 17 days at room temperature ± 25 °C and were replaced within 8 hours. After immersion, the specimens were measured again using Atomic Force Microscopy (AFM) to determine the final roughness. The data obtained were analyzed by using paired t-test. The analysis showed no significant difference between surface roughness before and after soaking with a denture cleansing tablet containing 48% sodium bicarbonate (p <0.05). This study concluded that there was no increase in the roughness of heat-cured acrylic resin after immersion in denture cleansing tablets containing 48% sodium bicarbonate.

KEYWORDS: Fittydent, heat-cured acrylic resin, surface roughness

INTRODUCTION

The denture is a tool to restore and maintain function, aesthetics, and health in the patient's oral cavity.¹ There are two types of dentures, namely full denture and removable partial dentures. A complete denture consists of dental elements and base.² Dental element is a replacement for natural teeth lost. The denture base is the part that rests on soft tissue and holds the denture element in place.¹ The denture base can be made of metal or a mixture of metal and acrylic resin, but the denture base that is still widely used is acrylic resin.³

Acrylic resin is a transparent resin with good clarity, color, and optical properties that remain stable under normal oral conditions.⁴ Acrylic resin used to manufacture denture base and polymerize by heat, chemical, and light polymerization methods. One example of acrylic resins that use the heat polymerization method is heat-cured acrylic resins, which are often used in the denture base manufacture because they are cheaper, more comfortable to apply, and use more straightforward tools.⁵ In dentistry, acrylic resin, which uses as a denture base, is polymethyl methacrylate (PMMA).⁶ PMMA chosen because it has non-irritating, non-toxic, insoluble in oral liquids, pleasing aesthetics, easy to process, good color stability, small dimensional change, and low water absorption.³

Dentures used in the mouth are essential to keep clean because if not cleaned properly, it can cause bad breath and accumulation of plaque or calculus. After all, the denture is used throughout the day by the patient to properly clean procedures. There are three methods for cleansing dentures, namely mechanical, chemical, and a combination of both.⁷ Mechanical methods are the most widely used method by patients except in elderly patients due to poor motoric coordination. In overcoming this, the chemical method becomes the right choice in the cleansing denture.⁸ The chemical method is to use a chemical denture cleansing agent, commonly used and available today, is sodium bicarbonate. Sodium bicarbonate is one of the active ingredients found in...
denture cleansing tablets. Sodium bicarbonate is a water-soluble white crystalline chemical, and this material widely used in the manufacture of toothpaste and denture cleansing agent.

Sodium bicarbonate first was used as a silver cleaner in 1920. Sodium bicarbonate has many beneficial properties, namely cheap, safe, low abrasive, soluble in water, neutralizing acids, compatibility with a fluor, and anti-bacterial abilities. Sodium bicarbonate has a vital base component contained in it. It will react with weak acids found in heat-cured acrylic resins that are the carboxyl group (COOH) to produce a precipitate. The resulting residue will occupy the acrylic resin's space to increase the acrylic resin's surface roughness.

Denture cleanser of heat-cured type acrylic resin thought to cause roughness on the denture's surface. It is a detrimental effect of acrylic resin denture cleansers. Surface roughness in acrylic resin dentures will increase the adhesion of bacteria, plaque, and food debris. The level of surface roughness of the denture base that can be tolerated ranges from less than 0.2 µm.

Based on Ozyilmaz chemical denture cleanser in tablet preparations showed PMMA acrylic resin's surface roughness changes. An effervescent denture cleanser tablet can significantly change surface roughness. Denture cleanser must use with caution depending on the base material of the denture. Durkan et al. also stated a significant increase in the surface roughness of polyamide denture base resin and PMMA after immersion in a cleansing solution prepared from sodium bicarbonate tablets. We are interested in researching denture cleansers' effect containing 48% sodium bicarbonate on surface roughness change of heat-cured acrylic resin to determine the level of effective cleansing of acrylic resin dentures. Therefore, the authors are interested in determining whether there is an effect denture cleaner 48% sodium bicarbonate on the surface roughness of the heat-cured acrylic denture base.

MATERIALS AND METHODS

Preparing specimens was done in the laboratory of the Faculty of Dentistry, Syiah Kuala University. The surface roughness and heat-cured acrylic resin denture prepared at the Physics Laboratory of Mathematics and Natural Sciences, Syiah Kuala University, from September to December 2019. The type of research carried out was an experimental laboratory. This study used 16 specimens of heat-cured acrylic resin in the shape of a plate according to the specifications of the American Dental Association (ADA) number 12, namely by p x l x t = (10 x 10 x 2) ± 0.5 mm.

Preparation of Heat-Cured Acrylic Resin Specimens

According to this research's specimen requirements, the treatment of acrylic resin specimen models preparation by dental laboratory assistants according to laboratory standards and according to this research's specimen requirements. Heat-cured acrylic resin specimens were immersed in distilled water for 24 hours at room temperature (25 °C ± 3 °C) to remove residual monomers.

Preparation of Denture Cleansing

Denture cleaning tablets used were the Fittydent brand. Fittydent is an alkaline peroxide group for soaking artificial teeth in the form of effervescent tablets. Fittydent denture cleansing tablets contain 48% Sodium Bicarbonate in 1 tablet. The denture cleansing solution is fittydent denture cleansing tablet of 48% Sodium Bicarbonate in 200 mL of water until the denture cleansing tablet wholly dissolved in water. Then immersed acrylic resin for 8 hours then cleaned by using aquadest.

Immering Method

The sample immersed in an artificial denture cleansing solution. Immersion of acrylic resin denture base using fittydent denture cleansing tablets recommended by the factory used 200 mL of water for 5 minutes for cleaning and used overnight to clean up dirt that hard to be cleaned. The solution was made by dissolving 1 Fittydent tablet containing 48% Sodium Bicarbonate into 200 mL of distilled water at room temperature (25°C ± 3°C) then immersed the denture base for 17 days by replacing the denture cleansing solution every 8 hours. Assumption of 17 days is the saturation point of acrylic resin on water content, and 8 hours is the rule to use Fittydent tablets as denture cleansers.

Atomic Force Microscopy Assay

Surface roughness was measured two times, namely before and after immersing in denture cleansing tablets. Heat-ured acrylic resin specimen for 16 samples measured for surface roughness with an Atomic Force Microscopy with a scale of 10 x 10 µm and a three-dimensional image. The initial preparation was to place the specimen on the
existing location on the device and then make sure the tip was right on the specimen surface and turned on the device and computer screen. During the scan, the cantilever’s tip (needle) moved back and forward along the surface of the specimen. Each deflection of the hand detected using a laser reflected in the direction, then through the laser mirror to the photodiode, it results displayed on the available computer screen.

RESULTS

The results of this study showed heat-cured acrylic resin surface roughness before and after immersion in a dental cleansing tablet containing 48% sodium bicarbonate. Heat-cured acrylic resin surface roughness was measured by using Atomic Force Microscopy (AFM). Based on the test results of heat-cured acrylic resin surface roughness before and after immersion in a dental cleansing tablet containing 48% sodium bicarbonate, each specimen’s roughness value varies.

Figure 1 showed the test results from Atomic Force Microscopy (AFM) in the form of a topographic image of specimen number 10 of roughness value (Ra). This image can be read by looking at the color on the surface and the valley’s depth obtained in the picture. The image used a scale of 10x10µm.

Statistic Analysis

The data obtained were analyzed using statistical tests with paired t-test with a significance level (p <0.05) to identify differences in the surface roughness of the initial and final examinations in the group. The statistical program used was the Statistical Package for Social Science (SPSS).

Table 1 shows the average value of heat-cured acrylic resin surface roughness before immersion in a dental cleansing tablet was 0.023±0.014µm. The average surface roughness value of heat-cured acrylic resin after immersion in dental cleansing tablets containing 48% sodium bicarbonate was 0.027±0.02µm. The statistical analysis results using the paired t-test were obtained p=0.675 (p<0.05), as in Table 1. This p-value showed no significant difference between surface roughness of heat-cured acrylic resin before and after immersion in a dental cleansing tablet containing 48% sodium bicarbonate.
DISCUSSION

This study aimed to determine the surface roughness of heat-cured acrylic resin immersion in a dental cleansing tablet containing 48% sodium bicarbonate for 17 days at room temperature ± 25°C. The immersion time was adjusted to the time of acrylic resin to reach saturation of water content. Before the heat-cured acrylic resin immersed in a dental cleansing tablet containing 48% sodium bicarbonate, it was first immersed in distilled water at room temperature ± 25°C for 1x24 hours. Immersion in distilled water aimed to remove residual monomers.  

Table 1 showed no change in heat-cured acrylic resin surface roughness by paired t-test, which showed no significant difference between heat-cured acrylic resin surface roughness before and after immersion in a dental cleansing tablet containing 48% sodium bicarbonate. It assumed the denture cleansing tablet containing 48% sodium bicarbonate had a large and soft crystalline structure, so there was no increase in roughness. Besides, sodium bicarbonate has a low abrasive level, so the increase in roughness was only slight.

There are three kinds of denture cleansing methods, namely mechanical, chemical, and combination techniques. Base immersion, the way of cleansing the denture by using denture cleansing tablets containing 48% sodium bicarbonate is a chemical method. The change in heat-cured acrylic resin surface roughness depends on the composition contained in the denture cleansing tablet. Not all of the content contained in the composition of the denture cleansing tablet is abrasive. According to Kurniawan et al., the method of cleansing by mechanical, namely by brushing, can increase surface roughness, which is influenced by the technique, frequency, and pressure used when brushing. Figure 1 explained how to read the results of the topographic image. The image with brightly colored images showed a high surface, dark colors showed a low surface, and brownish-red showed the surface between them. The deeper surface roughness that was read by AFM, the roughness value was slightly lower.

Immersion denture cleansing tablets containing 48% sodium bicarbonate of the brand Fittydent can be done for 5 minutes to clean the mild stain and immersed for 8 hours (assumed bedtime). In this study, immersion conducted to reach the saturation point of the water content that is 17 days, with water replace every 8 hours. It is assumed to be 51 days. These research results found that immersion carried out for 51 days did not affect surface roughness. This study’s results are supported by Sharma, which Fittydent recommended as a chemical denture cleansing agent that could use in the long term. Vinay also stated that the fittydent denture cleanser recommended a routine method of cleansing dentures to prevent denture stomatitis in-development induced by microbial biofilms.

The results obtained in this study were that there was no effect of immersion heat-cured acrylic resin denture base in denture cleanser containing 48% sodium bicarbonate on surface roughness. The average of heat-cured acrylic resin surface roughness before immersion in a dental cleansing was 0.023±0.014μm and after was 0.027±0.02μm. Despite an increase in the average value of surface roughness by 0.004 μm (Appendix 1). The increase that occurred in this study did not exceed the recommended surface roughness of the denture base. Quirynen et al. stated that the surface roughness for acrylic resins is 0.2 μm, where there is no significant reduction in bacterial colonization. Bacterial colonization will occur, starting at two μm. The researchers also mentioned 0.12 μm as a characteristic of smooth acrylic surfaces.

CONCLUSION

The research concluded that heat-cured acrylic resin immersion in dental cleansing tablets 48% sodium bicarbonate on surface roughness before and after no significant effect.

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