Effect of sisal fiber (*Agave sisalana*) and surface treatment on transverse strength in acrylic resin denture base repair

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ABSTRACT
Acrylic resin as a denture base material has a disadvantage; it is easily fractured. However, fractures can be repaired. This study aimed to reveal the effects of sisal fiber (*Agave sisalana*) and surface treatment on the transverse strength in acrylic resin denture base repair. A laboratory experiment was conducted on 30 acrylic resin samples with a size of 65 x 10 x 2.5 mm, consisting of group I (was on the repaired section), group II (sisal were to the repaired section) and group III (repaired were sisal fibers and applied with monomer). Transverse strength was measured using a universal testing machine. The data obtained were analyzed using 1-way ANOVA. The results showed that the lowest transverse strength was found in group I (88.30 ± 7.38 MPa) and the highest strength was in group III (133.45 ± 8.38 MPa). Based on the results of this study, it can be concluded that the use of sisal fiber and surface treatment can increase the transverse strength in acrylic resin denture base repair.
Keywords: acrylic resin, sisal fiber, surface treatment, monomer, transverse strength

INTRODUCTION

Tooth loss, which is a problem in oral cavity, can cause alveolar bone resorption and migration of adjacent teeth, as well as affect supporting tissues, the roles of masticatory muscles, health of the oral cavity, and a person's confidence. To prevent these things, a rehabilitation treatment with denture is needed.[1] One of the most commonly used dentures is partial removable denture. In its use as a denture base material, acrylic resin also has a disadvantage; it is easily fractured. This disadvantage often causes problems such as fracture of denture base due to compressive forces in the oral cavity and due to fall.[2]

Fracture of acrylic resin denture base can be repaired. The material used for the repair should be able to provide good strength, good color, good dimensional stability, affordable prices, easy, and fast application. The repair of acrylic resin denture base can be done by applying new acrylic resin on the fractured section.[3] Several efforts have been made to improve the transverse strength in the repair of acrylic resin denture base by adding fiber as reinforcing materials to the acrylic resin repair. The addition of fiber may produce good transverse strength, good adhesive bonds between fiber and acrylic resin, good aesthetic quality, and ease of application of fiber in acrylic resin.[4] Some natural fibers that are widely used to reinforce dental materials are hemp, kenaf, sisal, and abaca.[5]

One type of natural fibers that can be developed is sisal fiber (*Agave sisalana*) which has the mechanical properties as reinforcement of matrix.[6,7] Sisal fiber can be used to reinforce acrylic resin denture base because it is easy to apply, affordable, and has good mechanical properties as a reinforced polymer material.[7,8]

Success in improving the transverse strength in the repair of acrylic resin denture base, in addition to relying on fiber addition, also depends on the adhesion. Surface treatment is a treatment that can be performed to produce good adhesion. The surface to be repaired will be treated with particular chemicals, such as ethyl acetate, chloroform, acrylic resin monomers. In fact, treatment with acrylic resin monomers can cause gap and pit formation due to resin dissolution, which then produces strong adhesion.[9] This study aimed to examine the effect of sisal fiber (*Agave sisalana*) and surface treatment on transverse strength in acrylic resin denture base repair.

METHODS

This research on the effect of sisal fiber and surface treatment using monomers on the transverse strength in the repairs of acrylic resin denture base was conducted by laboratory experiment. The research samples were acrylic resin blocks with a size of 65 x 10 x 2.5 mm, consisting of group I (monomer was applied to the repaired section), group II (sisal fiber was given to the repaired section, and group III (the repaired section was given sisal fiber and applied with monomer).

The instruments used in this research were tool for making heat-polymerized acrylic resin samples, cold-cured acrylic resin stirrer, burs for pre-

paration, and universal testing machine for transverse strength testing. The materials used in this research were heat-cured acrylic resin to make the samples, cold-cured acrylic resin for repair materials, heat-cured acrylic resin processing materials, sisal fibers with a size of 30 x 5 mm, 6% NaOH for the alkalization of sisal fiber, and heat-polymerized acrylic resin monomers. This research was conducted by making research samples, preparing the research samples, making sisal fibers, repairing the research samples, and testing the transverse strength. The data obtained from the results of the transverse strength testing were collected and tabulated according to the treatment groups, followed by a statistical analysis using 1-way Anova.

RESULTS

Based on the results of this study, the lowest mean transverse strength on denture base repair was found on the group where monomer was applied to the repaired section (88.30 ± 7.38 MPa) and the highest (133.45 ± 8.38 MPa) was found in the group where the repaired section was applied with monomers and given sisal fibers (Table 1).

The 1-way Anova test showed a significant difference ($p<0.05$) in the transverse strength among group I, II, and III (Table 2). Based on these results, it can be concluded that there is an effect of addition of sisal fiber and application of surface treatment using monomers on the transverse strength in acrylic resin denture base repair.

LSD analysis was used to determine which groups gave significant differences in the transverse strength among the three groups (Table 3). The results of LSD analysis for all these groups showed that there was a significant difference in the transverse strength among all the treatment groups ($p<0.05$).

Table 1 Mean and standard deviation of transverse strength (MPa) in acrylic resin denture base repair

Group	Mean±Standard Deviation
Group I	88.30 ± 7.38
Group II	113.65 ± 7.31
Group III	133.45 ± 8.38

Group I: Repaired section applied with monomer
Group II: Repaired section given sisal fiber
Group III: Repaired section applied with monomer and given sisal fiber

DISCUSSION

The results of the study on the effect of sisal fiber and surface treatment using monomers on the transverse strength in acrylic resin denture base repair showed that the highest mean was found in the group repaired with monomer application and sisal fiber addition. The application of surface treatment by wetting the surface of acrylic resin denture base with chemical substances in the form of acrylic resin monomers can produce stronger adhesive bonds.[9] The fractured denture base surface will come in contact with acrylic resin monomers, dissolve, form gaps and pits, and produce mechanical interlocking bonds.[8,10] The application of surface treatment using monomers in the repaired section of acrylic resin denture base can produce strong adhesive bonds.[10] The penetration of repair materials to the base which undergoes erosion because acrylic resin denture base monomers dissolve will create bonds between polymer chains, thus improving the mechanical strength.[11]

Addition of fiber on acrylic resin denture base can improve the mechanical strength of the acrylic resin because the force received by the plate surface will be evenly distributed on the acrylic resin

Table 2 Results of 1-way ANOVA test on transverse strength in acrylic resin denture base repair

	Sums of Square	Degree of freedom	Mean Squares	F	Sig.
Among groups	7883.37	2	3941.68	66.343	0.000
Within group	1604.17	27	59.414		
Total	9487.54	29			

Table 3 LSD test on transverse strength in acrylic resin denture base repair

Group	Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence interval	
					Lower Bound	Upper Bound
Group I	Group III	-39.14400*	3.44714	0.000	-46.2169	-32.0711
	Group II	-25.34400*	3.44714	0.000	-32.4169	-18.2711
Group II	Group III	-13.80000*	3.44714	0.000	-20.8729	-6.7271
	Group I	25.34400*	3.44714	0.000	18.2711	32.4169
Group III	Group II	13.80000*	3.44714	0.000	6.7271	20.8729
	Group I	39.14400*	3.44714	0.000	32.0711	46.2169

plate, so fiber could absorb greater energy compared to acrylic resin plate without fiber addition.[11,12] Natural fibers, in the form of sisal fibers, have a good mechanical property as a reinforcing material of matrix.[7,8] The lowest mean transverse strength was found in the group where the repaired section was only applied with acrylic resin monomers as surface treatment. In fact, although acrylic resin denture repair material could penetrate into the repaired section, its transverse strength is 40-60% lower than the strength before fracture occurs. In the polymerization process of acrylic resin denture repair, not all monomers can be converted into polymers, so the remaining monomers can affect the mechanical properties of the acrylic resin denture repair.[13]

There were significant differences in the group only applied with monomers, the group only given sisal fiber, and the group applied with monomers and given sisal fiber. In the group where the repaired section was only applied with acrylic resin monomer, gaps and pits were formed, then the repair materials could penetrate into the acrylic resin, creating mechanical interlocking and adhesive bonds with minimum effects.[11,14] Addition of sisal fiber can improve the transverse strength of the repaired sections because sisal fiber can get embedded in resin.[15]

Based on the results of this study, it can be concluded that the addition of sisal fiber (*Agave sisalana*) and application of surface treatment using monomers can improve the transverse strength in acrylic resin denture base repair.

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