Journal of Research in Medical and Dental Science
2021, Volume 9, Issue 5, Page No: 42-47

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Effect of Alum Disinfectant Solutions on Some Properties of a Heat-Cured Acrylic Resin

Sundus Abdul Alhussain Jasim, Shorouq M Abass*

Department of Prosthodontics, College of Dentistry, University of Baghdad, Bab-Almoadham, Baghdad, Iraq

ABSTRACT

Objective: The objective of the study was to investigate the effect of immersion in different disinfectant solutions, on hardness and surface roughness of a heat-cured acrylic resin.

Materials and Methods: Specimens were immersed in distilled water, commercial alum in concentration 5%,10% and sodium hypochlorite1% for 60 hour and 180 hours (n=10). After periods of immersion, shore hardness and surface roughness were evaluated using shore D hardness tester (time TH210 shore D hardness tester) and roughness tester, respectively. The data were analyzed using one-way ANOVA and Tukey HSD test, at a level of significance of 5%.

Results: The hardness mean values ranged from 82.856± 1.674 to 86.653 ± 1.226 and roughness main values from 0.177± 0.139to 1.923± 0.510. There is no difference in hardness and roughness between groups and times (p>0.05).

Conclusions: Within the limitations of this study there is no deference between 5% and 10%alum disinfectant solution, it is possible to conclude that alum and sodium hypochlorite , as alternative disinfectant solutions for acrylic resin devices, did not promote effects on hardness and polishing of a heat-cured acrylic resin used for the fabrication of prostheses, neither in 60 hours nor180 hours .

Key words: Alum, Acrylic denture base specimens, Disinfection

HOW TO CITE THIS ARTICLE: Sundus Abdul-Alhussain Jasim, Shorouq M Abass, Effect of Alum Disinfectant Solutions on Some Properties of a Heat-Cured Acrylic Resin, J Res Med Dent Sci, 2021, 9 (5):42-47.

Corresponding author: Shorouq M Abass

e-mail: ali.mario28@yahoo.com

Received: 20/04/2021

Accepted: 13/05/2021

INTRODUCTION

For several years, the use of acrylic resin as a denture base material has been suggested. Ideally, denture base material should acquire some key physical attributes that include biocompatibility, large bond strength with artificial teeth, in addition to good mechanical properties [1]. The popular form of oral candidiasis is denture stomatitis, characterized by inflamed and erythematous mucosa that is covered by the denture [2] . Among complete denture users, the prevalence varies between approximately 20% and 80% [3,4]. Although it is multifactorial disease, the colonization of the inner surface of the denture by *Candida albicans* one of The main causative factors [5].

Denture will provide the suitable conditions for the adhesion and multiplication of *C. albicans* because it provide an aerobic and acidic condition in addition it will cover the supporting mucosa making it far away from the cleaning action of saliva and oral muscles, so the prosthetic surfaces will covered by *C. albicans* biofilms [6]. Due to the brittle nature of acrylic resins, mechanical cleaning is difficult and unreliable in controlling bacteria in dentures. As a result, immersing prosthetic surfaces in disinfectant solutions has become a standard method to enhance cleansing [7,8]. Glutaraldehyde and sodium hypochlorite are the most commonly available alternatives. The most commonly solutions, glutaraldehyde and sodium hypochlorite used [9]. However, these solutions possess a number of disadvantages, such as glutaraldehyde toxicity, metals corrosion, skin irritation and the staining of tissue by sodium hypochlorite [9,10]. As a result, there is a need to find alternate disinfectant solutions that do not harm the material's properties. Aluminum potassium sulfate is naturally available products that used for centuries in handling diseases of human and they encompass constituents of therapeutic value. Naturally available products are cheap, environmentally safer and easily available [11]. This solution is a promising disinfectant in medicine and the food industry. Aluminum potassium sulfate (alum) having chemical formula KAL (SO4).12H20 and generally having no odor, no color sold crystal that return white in color in air that used in food preservation and water purification. The recommendation by Counter Advisory Panel of U.S.A FDAs (Food and Drug Administration) to use alum as active ingredient part in mouth wash [12]. Aluminum potassium sulfate could be considered as a harmless material and has a low toxicity in laboratory animals [13]. As a result, the aim of this analysis was to see how various disinfectants affected the stiffness and roughness of a heat-cured acrylic resin.

MATERIALS AND METHODS

Eighty heat cured acrylic resin specimens were fabricated, (major base 20, heat cure acrylic, ITALY), with dimension 65mm X 10mm 65x10x2.5mm specimens were polymerized by , immersion of the flask in the water bath. Short curing cycle was used following the ADA specification No. 12 [I4] for denture base materials. The cycle included putting the flask in the water bath for hour and a half at 70 C° and half an hour at 100 C°.

After the curing cycle is completed, the flask left to cool at room temperature then de-flasking was done and acrylic specimens were removed.

All acrylic specimens (except those prepared for surface roughness test) were finished to remove excess materials by using prosthetic engine with acrylic burs and stone burs with continuous water cooling to avoid over heating that might distort the specimens. The process of polishing was accomplished by using rouge placed in dental lathe machine with speed of 1500 rpm with continuous water cooling until glossy surface of specimens was obtained. According to the disinfectant and the amount of time submerged, the specimens were randomly divided into eight classes (n=10).

Immersion in disinfectant solutions

Each specimen was immersed in 10 m L of distilled water (control), Alum 5%-10%, 1 % sodium hypochlorite. The samples were maintained in solution for 60 hours and 180 hours, without interruption, in closed containers. None of the solutions was replaced during this period. After immersion, the specimens were washed in distilled water and dried with absorbent paper.

Surface hardness test

Shore D hardness test has been used in this study since it is the suitable one that used for acrylic resin materials [15]. Surface hardness test was performed using shore D hardness tester (Time TH210 Shore D hardness tester) (Figure 1).

Surface roughness test

Surface roughness of acrylic resin can be affected by the feature of material itself, technique of polishing, and skill of the operator [16].

Surface roughness test I-Specimen

Espoo dimensions

For surface roughness test the acrylic specimens were made with the following dimensions (65x10x2.5) mm length, width, and thickness respectively according to instructions of device as shown in figure (2). The specimens were kept in distilled water at 37 C° for 48 hours before establishing the test according to ADA specification No. 12 [14] (Figure 2).

Statistical analysis

The obtained data from experimental tests was statistically analyzed using SPSS (Statistical Package for Social Science) version 20 which includes the following:

Descriptive statistics:

- ✓ Mean.
- ✓ Standard deviation (SD).
- ✓ Minimum (Min).
- ✓ Maximum (Max).

One way analysis of variance (ANOVA) test was used to assess the difference between more than two groups. If there was a statistically significant difference, then Tukey HSD test used to reveal the difference between each two groups.

RESULTS

Shore D hardness result are display in table ranging from 82.856 ± 1.674 to 86.653± 1.226.

There was no statistical significance between the groups and times. There was no significant statistical difference between the disinfectant solutions and times (p>0.05) (Tables 1 and 2). For the surface roughness test (Tables 3 and 4), values ranged from 0.177 ± 0.139 to 1.923 ± 0.510µm. In this study the results a statistically non-significant increase in surface hardness as compared with control group with acceptable level. surface roughness means value significant increase with acceptable limit. Mean values of surface roughness were (0.717) and (1.001pm) for 60-hour immersion. The Mean values of surface roughness were (1.234) and (1.923pm) for180 hour immersion.

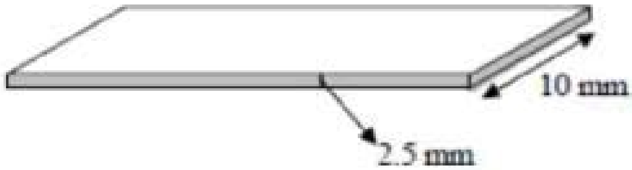

Figure 1: Surface hardness test specimen's dimensions.

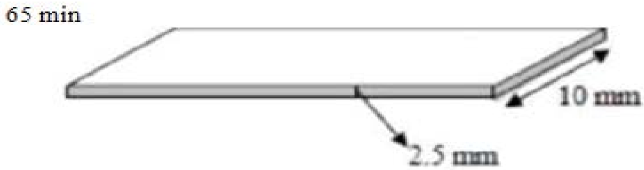

Figure 2: Surface roughness test specimen's dimensions.

Table 1: Descriptive and statistical test of hardness among groups by time using factorial analysis of variance (ANOVA).

Time	Groups	Minimum	Maximum	Mean	±SD	F	P value	Partial eta square (Effect size)
60h	Water	82.866	86.433	84.81	1.291	2.504	0.066^	0.094
	NAOHCL	81.924	86.6	84.806	1.647			
	5 % Alum	78.566	89	85.366	2.814			
	10 % Alum	84.333	89	86.653	1.226			
180h	Water	82.9	87.066	85.053	1.17	3.044	0.034*	0.113
	NAOHCL	80.733	85.2	82.856	1.674			
	5 % Alum	80.633	88.466	83.373	2.159			
	10 % Alum	82.333	85.666	84.17	1.258			

^=not significant at p>0.05, *=significant at p<0.05.

Table 2: Multiple pairwise comparisons of hardness between groups in the 180-h using Tukey honestly significant difference (Tukey HSD).

(I) Groups	(J) Groups	Mean Difference (I-J)	P value
Water	NAOHCL	2.197	0.0306*
	5 % Alum	1.68	0.1444^
	10 % Alum	0.883	0.6690^
NAOHCL	5 % Alum	-0.517	0.9107^
	10 % Alum	-1.313	0.3378^
5 % Alum	10 % Alum	-0.797	0.7356^

^=not significant at p>0.05, *=significant at p<0.05.

Table 3: Descriptive and statistical test of Roughness (µm) among groups by time using factorial analysis of variance (ANOVA).

Time	Groups	Minimum	Maximum	Mean	±SD	F	P value	Partial Eta Squared
60h	water	0.543	1.281	0.895	0.218	1.057	0.373^	0.042
	NAOHCL	0.56	0.971	0.717	0.139			
	5 % Alum	0.538	1.631	1.001	0.318			
	10 % Alum	0.77	1.279	0.954	0.18			
180h	water	0.622	1.823	10.234	0.432	6.468	0.001*	0.212
	NAOHCL	1.206	2.751	1.923	0.51			
	5 % Alum	1.135	2.505	1.843	0.38			
	10 % Alum	0.992	2.718	1.683	0.618			

^=not significant at p>0.05, *=significant at p<0.05.

Table 4: Multiple pairwise comparisons of roughness (µm) between groups in the 180 H using tukey honestly significant difference (Tukey HSD).

(I) Groups	(J) Groups	Mean Difference (I-J)	P value
Water	NAOHCL	-0.6891	0.0008*
	5 % Alum	-0.6094	0.0036*
	10 % Alum	-0.4492	0.0508^
NAOHCL	5 % Alum	0.0797	0.9663^
	10 % Alum	0.2399	0.5027^
5 % Alum	10 % Alum	0.1602	0.7858^

^=not significant at p>0.05, *=significant at p<0.05.

DISCUSSION

A home-made disinfection technique may be used to immerse plastic resin prosthetic appliances in solutions. However, these disinfectants interact with the characteristics of the polymer substance [17,18]. With this in consideration, the current research explored the effect of immersion in various disinfectants on the micro - hardness and roughness of a heat-cured resin. After immersion in alum 5% and10% Alum, these properties were no different from purified water, which was used as a monitor, and 1% sodium hypochlorite, which is considered the paradigm in disinfection.

Immersion of the acrylic resin for 60 to 180 hours replicates 10 minutes per day of disinfectant touch for one and three years, respectively. Since the immersion was persistent, the difficulty was more challenging than that encouraged by sporadic exposure. Recommended length of usage for an acrylic resin denture is five years, and the extrapolated period is ten years [18]. Therefore, in the current analysis, the acrylic resin properties were maintained following immersion in disinfectant solutions for a span of time equivalent to the functional life of the dentures. Among other considerations, such as occlusion and the state of the patient's residual ridge, the characteristics of acrylic resin have a significant effect on the usable life of the denture since tolerance and contamination are important to durability and are related to the material's efficiency [19].

For chemical disinfection of the denture base, several active agents have been used. Because of its broad-spectrum usefulness, sodium hypochlorite is considered the gold standard. Nonetheless, it has adverse side effects such as corrosive activity on plastics, denture staining, and an irritant effect on the skin [9,10]. Hydrogen peroxide, on the other hand, has antimicrobial effects due to its alkaline origin [20]. The use of hydrogen peroxide can result in color change and a reduction in flexural strength [21]. Finally, alum is a low-cost solution that has been shown to be effective against *Candida albicans*, Streptococcus mutans, Staphylococcus aureus, Escherichia coli, and Bacillus subtili [9,11]. In the case of C. In the presence of *Candida albicans*, the major organism implicated in denture stomatitis, alum behaved similarly to sodium hypochlorite and chlorhexidine, and outpaced sodium perborate-based tablets [10].

Immersion in solutions can cause the material to dissolve due to polymer degradation [17]. When a polymer is exposed to a solvent, it undergoes hydrolytic degradation because of the chemical reaction between the solution and the organic matrix in the available spaces between the polymer chain [17,18]. Furthermore, the active agents can cause accelerated chemical degradation [22], However, as previously found in a previous study [8], agents with acidic and alkaline activity did not produce a better chance than the hydrolytic solution. In the situation of hydrogen peroxide, this can be clarified by the selective diffusion of hydroxyl radicals [21].

The impact of polymer matrix deterioration is first seen as an increase in overall roughness [23-25], which encourages microbe colonization [5]. Immersion in disinfectant solutions did not result in an improvement in roughness in the current sample, contrary to previous findings [26-28]. Furthermore, in the current analysis, roughness after immersion did not reach the 0.2 m mark, which is the bearable boundary for preventing *Candida albicans* stickiness [28,29]. The roughness of acrylic resin following immersion in alum or sodium hypochlorite for 60 or 180 hours shows little deviation from immersion in purified water or sodium hypochlorite for the same time spans.

In regard to the interaction with disinfectant solutions, the mechanical and rheological characteristics of the polymer substance are influenced by the density of the cross-links. The polymer matrix differs based on the form and structure of the acrylic resin and can include pigments, cross-linking agents, load, and fibers. The use of heat-curable acrylic resin with a cross-linking agent favored the preservation of microhardness and polishing.

CONCLUSION

Under the study's limitations, it is possible to assume that using alum or sodium hypochlorite as a replacement disinfectant for acrylic resin has no short- or long-term harmful effects on the stiffness or polishing of heat-cured acrylic resin being used on, neither in the short nor long term.

REFERENCES

1. Diwan R. Materials prescribed in the management of edentulous patients. Prosthodontic treatment for edentulous patients. Edn 2004; 12:190-207.
2. Sullivan DJ, Moran GP, Pinjon E, et al. Comparison of the epidemiology, drug resistance mechanisms, and virulence of *Candida dubliniensis* and *Candida albicans*. FEMS Yeast Res 2004; 4:369-376.
3. Bianchi CM, Bianchi HA, Tadano T, et al. Factors related to oral candidiasis in elderly users and non-users of removable dentalprostheses. Rev Inst Med Trop Sao Paulo 2016; 58:17.
4. Emami E, Séguin J, Rompré PH, et al. The relationship of myceliated colonies of *Candida albicans* with denture stomatitis: an in vivo/in vitro study. Int J Prosthodont 2007; 20:514-520.
5. Gendreau L, Loewy ZG. Epidemiology and etiology of denture cleansers against *Candida albicans* adherent to acrylic denture base resin: An in vitro study. Indian J Dent Res 2012; 23:39-42.
6. Akpan A, Morgan R. Oral *candidiasis*. Postgraduate Med J 2002; 78:455-459.
7. Asad T, Watkinson AC, Huggett R. The effects of various disinfectant solutions on the surface hardness of an acrylic resin denture base material. Int J Prosthodont 1993; 6:9-12.
8. Sun HW, Feigal RJ, Messer HH. Cytotoxicity of glutaraldehyde and formaldehyde in relation to time of exposure and concentration. Pediatr Dent 1990; 12:303-307.
9. Kumar MN, Thippeswamy HM, Raghavendra Swamy KN, et al. Efficacy of commercial and household denture disinfectant solutions to heat-cured acrylic resin RGO. Rev Gaúch Odontol 2019; 67:e201900525.
10. Nascimento MS, Silva N, Catanozi MPLM, et al. Avaliação Comparativa de Diferentes Desinfetantes na Sanitização de Uva. Braz J Food Technol 2003; 6:63-68.
11. Osuala FI, Ibidapo-obe MT, Okoh HI, et al. Evaluation of the efficacy and safety of potassium aluminium tetraoxosulphate (Vi)(ALUM) in the treatment of tuberculosis. Eur J Biolo Sci 2009; 1:10-15.
12. Olmez A, Can H, Ayhan H, et al. Effect of an alum-containing mouthrinse in children for plaque and salivary levels of selected oral microflora. J Clin Pediatr Dent 1998; 22:335-340.
13. Bnyan IA, Alta'ee AH, Kadhum NH. Antibacterial activity of aluminum potassium sulfate and Syzygium aromaticum extract against pathogenic microorganisms. J Nat Sci Res 2014; 4:137-141.
14. American Dental Association Specification NO. 12. For denture base polymer guide to dental materials and devices, 7th edition, Chicago Illiniois 1999.
15. Unalan F, Dikbas I. Effects of mica and glass on surface hardness of acrylic tooth material. Dent Materials J 2007; 26:545-548.
16. Corsalini M, Boccaccio A, Lamberti L, et al. Analysis of the performance of a standardized method for the polishing of methacrylic resins. Open Dent J 2009; 3:233.
17. Kimoto S, Kimoto K, Murakami H, et al. Survival analysis of mandibular complete dentures with acrylic-based resilient liners. Gerodontology 2013; 30:187-193.
18. Kanno T, Nakamura K, Ikai H, et al. Novel denture-cleaning system based on hydroxyl radical disinfection. Int J Prosthodont 2012; 25:376-380.
19. Nakahara T, Harada A, Yamada Y, et al. Influence of a new denture cleaning technique based on photolysis of H2O2 on the mechanical properties and color change of acrylic denture base resin. Dent Mater J 2013; 32:529-536.
20. Lee SY, Huang HM, Lin CY, et al. Leached components from dental composites in oral simulating fluids and the resultant composite strengths. J Oral Rehabil 1998; 25:575-88.
21. de Oliveira JC, Aiello G, Mendes B, et al. Effect of storage in water and thermocycling on hardness and roughness of resin materials for temporary restorations. Materials Res 2010; 13.
22. Arévalo E, Maldonado V, Bizarro S. Análisis microscopic de la adherencia de Candida albicans in vitro sobre resina acrílica utilizada para bases de dentaduras procesada con tres diferentes técnicas. Rev Odontol Mex 2006; 10.
23. Azevedo A, Machado AL, Vergani CE, et al. Effect of disinfectants on the hardness and roughness of reline acrylic resins. J Prosthodont 2006; 15:235-242.
24. Azevedo A, Machado AL, Vergani CE, et al. Hardness of denture base and hard chair-side reline acrylic resins. J Appl Oral Sci 2005; 13:291-295.
25. Ural Ç, Şanal FA, Cengiz S. Effect of different denture cleansers on surface roughness of denture base materials. J Adv Prosthodont 2016; 8:333-338.

26. Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: A review of the literature. Dent Mater 1997; 13:258-269.
27. Rao DC, Kalavathy N, Mohammad HS, et al. Evaluation of the surface roughness of three heatcured acrylic denture base resins with different conventional lathe polishing techniques: A comparative study. J Indian Prosthodont Soc 2015; 15:374-380.
28. Rodrigues SB, Leitune VCB, Hashizume LN, et al. Polímero de MMA para base de dentadura com a adiço de subnitrato de bismuto. RFO. 2014; 19:166-171.
29. Jaikumar RA, Karthigeyan S, Ali SA, et al. Comparison of flexural strength in three types of denture base resins: An in vitro study. J Pharm Bioallied Sci 2015; 7:461-464.