Influence of SOLO disinfectant on some properties of different denture lining materials

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ABSTRACT

Background: Denture lining materials are widely used in prosthodontic treatment and management of traumatized oral mucosa. A contaminated prosthesis can provide a source of cross-contamination between patients and dental personnel as well as a cause for denture stomatitis. Therefore, denture disinfection has been recommended as an essential procedure for maintenance of a healthy oral mucosa. This study investigated the effect of SOLO disinfectant solution on some properties of different denture lining materials.

Materials and methods: Three different solutions were used in this study; SOLO disinfectant solution, sodium hypochlorite solution, and water on three types of acrylic denture lining materials; hot cure, cold cure, and soft acrylic resin. Twenty seven disk-shaped samples were used to evaluate the color stability and forty five rectangular samples were used for testing the surface micro hardness and surface roughness of the different denture lining materials. Data measurements of the color stability, surface hardness, and surface roughness were analyzed and compared statistically.

Results: The color stability for the tested denture lining materials was insignificantly affected ($p>0.05$) by the immersion in the SOLO disinfectant solution. There was a highly significant difference ($p< 0.01$) in the surface hardness of the hot cure while it was insignificant ($p>0.05$) for cold cure denture lining materials when immersed in the SOLO disinfectant solution. For surface roughness there was no significant difference ($p>0.05$) by immersion in SOLO disinfectant solution for the different denture lining materials.

Conclusions: Based on the results of this study SOLO disinfectant solution produced no adverse effect on the color stability, surface hardness, and surface roughness of the hot cure, cold cure, and soft acrylic denture lining materials
Keywords: acrylic, immersion, SOLO, color, hardness, roughness. (J Bagh Coll Dentistry 2012;24(3):36-41).

INTRODUCTION

Denture lining materials are widely used as adjuncts in the prosthodontic treatment and management of traumatized oral mucosa. However, the soft-lined dentures have been associated with Candidal growth especially in soft lined mandibular dentures more than unlined maxillary dentures.[1] One of the etiological factors involved in denture stomatitis is the lack of denture sanitation. The need to remove denture plaque at regular intervals, especially on the tissue fitting surfaces of dentures, was emphasized to prevent denture stomatitis. In addition, the unpolished surface of the denture was a suitable site for Candida proliferation and *C. albicans* penetration was greater on the unpolished denture surface.[2]

Cross contamination of dental personnel may occur during denture repair or adjustment when particles of the internal surface become airborne during grinding.[3] Also, dental professionals and patients should be careful of denture-borne microorganisms to cause oral/systemic diseases. Thus, they should take into consideration the appropriate sanitization procedures to reduce the reservoir of microorganisms and to prevent cross contamination.[4]

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Denture disinfection has been recommended as an essential procedure for preventing cross-contamination and the maintenance of a healthy oral mucosa. Several studies have investigated the disinfection efficiency of several chemical solutions for denture lining materials. Furukawa *et al.*[5] stated that the immersion technique was more effective than the spray technique, however the Chlorine dioxide did not reach the minimal standard of disinfection for the tested denture liners. Pavarina *et al.*[6] recommended scrubbing the denture with a disinfecting solution combined with immersion for 10 minutes and this was effective in reducing the microbial growth. Barnabe *et al.*[7] also suggested brushing the dentures and they used coconut soap and 0.05% sodium hypochlorite to significantly reduce the clinical signs of denture stomatitis, however the *C. albicans* counts did not decline.

Other examiners were careful to study the effect of the chemical disinfection on the physical and mechanical properties of the different types of denture acrylic resin. Some of these chemical disinfectants caused color shifts and surface damage including increased surface roughness.[8-11]

Some studies for denture disinfection have been proposed, including immersion in chemical solutions and microwave irradiation. They found that microwave disinfection increased the surface roughness and adversely affected the surface texture and produced clinically unacceptable alterations in the adaptation of maxillary acrylic resin denture bases to the stone casts.[12-14]

Abass *et al.*[15] evaluated the influence of immersion in NaCl solution, immersion in water, and in dry air during microwave disinfection on dimensional stability, water sorption, and water solubility of hot cure, cold cure, and soft acrylic resin. They suggested that immersion in NaCl solution when used for hot cure acrylic resin affected the dimensional stability, while for soft acrylic resin the dimensional stability could be affected when immersed in water during microwave disinfection. Water sorption for cold cure acrylic resin significantly changed when immersed in water and when placed in dry air during microwave disinfection. Also the surface roughness and hardness were evaluated by Ibrahem[16] who found that the used of the same methods adversely affected the surface roughness.

Our hypothesis was that immersion of the acrylic resin denture lining materials in the SOLO disinfectant solution could adversely affect some of the acrylic resin's properties. The study was aimed at assessing the effect of SOLO disinfectant, sodium hypochlorite, and water on three-different types of acrylic denture base materials in association with the surface hardness, surface roughness, and color stability.

MATERIALS AND METHODS

Three types of denture lining materials were used in this study; hot cure acrylic resin denture base material (SR Triplex Hot, Ivoclar Vivadent, Liechtenstein), soft acrylic resin for relining dentures (Vertex™ Soft, Vertex-Dental, Netherlands), and cold cure acrylic resin for repair and relining of dentures (MEGA-A, Megadenta Dentalprodukte GmbH, Germany).

The properties of these materials were evaluated with the influence of the immersion in water, Sodium hypochlorite solution, & SOLO disinfectant solution on the color stability, surface roughness, and surface hardness of the different denture lining materials.

Sodium hypochlorite solution was prepared by using the household bleach of 5.25% hypochlorite solution and diluted with water at a ratio of 1 part of bleach: to 10 parts of water to make 1:10 ratio and the samples were immersed in this solution for 10 minutes according to the ADA recommendation for disinfection.[17] Preparation of SOLO Disinfectant solution (SOLO, Ebiox Ltd., Healthcare Enterprise House, UK.) and duration of immersion were according to the manufacturer's instructions.

Sample preparation was conducted according to the manufacturer's recommendations for each type of denture lining material. After finishing and polishing, all the samples were immersed in distal water at 37˚ C for 50 hours.[18] The samples were then divided into nine test groups according to the type of denture lining material and immersion solution used, as shown in table 1.

Color stability was evaluated using twenty seven disk-shaped samples with a diameter of 50 mm and thickness of 1 mm in accordance with ADA specification no. 12.[19] with the UV-Visible Recording Spectrophotometer (UV-160A, Shimadzu Corp., Kyoto, Japan) was used for evaluation of color stability at a wave length of (400-500 λ). Two readings were obtained for each sample; one before the immersion and one after.

Surface roughness & surface hardness were assessed with forty-five rectangular samples with dimensions of (20) mm × (12) mm × (3) mm.

The acrylic samples were tested for surface micro hardness test with Vicker's hardness test machine (VHN- Kg/mm2) with a load of 10 Kg. Three indentations were made at different points on each sample, and then the mean reading was calculated for each sample. Two readings were evaluated; one before the immersion and one after (figure 1).

Acrylic samples were tested for surface roughness, Ra (μm), with the Profilometer device (surface roughness tester). Two measurements were taken for each sample and the average reading was then calculated. Two readings were recorded for each sample; one before the immersion and one after.

Statistical analysis included descriptive statistics and paired sample t-test at a significance level of $p<.05$.

RESULTS

The results of this study revealed that there was no significant change ($p > .05$) in the color of the test samples for all of the test groups (table 2 & 3).

The surface hardness of the hot cure acrylic resin highly significantly increased by immersion in water and the SOLO solution, ($p < .01$), while it was insignificantly affected by the immersion in the sodium hypochlorite solution, ($p > .05$). For the cold cure acrylic resin the surface hardness was significantly increased by immersion in water ($p < .05$) and insignificantly affected by immersion in sodium hypochlorite and SOLO disinfectant solution ($p > .05$), see table (4&5). The results for the surface hardness test for the soft acrylic resin samples were excluded from the statistical analysis because they didn't register any readings due to the elasticity of the material that prevented any permanent deformation.

Surface roughness for the samples of all of the test groups was unaffected (p > .05) by immersion in any of the solutions, as shown in table (6 & 7).

Figure 1: Surface Micro-Hardness indention

DISCUSSION

The hypothesis that the immersion of acrylic denture lining in a SOLO disinfectant solution adversely affects the color stability was rejected. It seems that SOLO disinfectant solution did not have any effect on the color of the different denture lining materials. The results of Ma *et al*.[8] were in agreement with this study, but were in disagreement with the finding of Hong *et al*.[11] who found that the influence of denture cleansers on the color stability of denture base acrylic resins varied according to the type of denture cleanser used. This may be related to the fact that the time of immersion in this study was too short to produce any change in the color, while their duration of immersion was 12 hours. Their solutions were used as denture cleansers, while the goal in this study was for disinfection only and according to the manufacturer's instructions, for SOLO disinfectant solution, this imposed a short duration of immersion. Also, they used a different device for measurement of color stability and their chemical disinfection solutions were not the same, so this could have had an influence on the difference between the outcomes.

The hypothesis that SOLO disinfectant solution could adverse effect the surface hardness was rejected. The surface hardness of hot cure acrylic denture lining material was significantly increased after immersion in SOLO disinfectant solution for 10 minutes, while it was insignificantly affected for the cold cure acrylic resin, although there was some enhancement in surface hardness. This difference in surface hardness could be explained by the findings of Mohamed *et al*.[20] who stated that the residual monomer content for hot cure acrylic resin samples was less than that of cold cure and the higher residual monomer content in the cold cure acrylic resin acted as a plasticizer, subsequently reducing the properties of the cold cure acrylic resin.[21] The amount of residual monomer that leaked out of the hot cure acrylic ended in a higher surface hardness, but with the cold cure acrylic resin even with the escape of some of the residual monomer into the immersion solution it was not enough to enhance the surface hardness to a highly significant difference. In addition, Machado *et al*.[12] and Braun *et al.*[22] both found that the cold cure reline materials exhibited significantly lower hardness mean values than the hot cure relining materials. Also, Braun *et al.*[22] further stated that the immersion in water caused leaching of residual monomer from denture base materials that the contributed to the higher surface hardness. Asad *et al*.[23] confirmed in their study that disinfection by immersion in chemical solution did not adversely affect the surface hardness of acrylic resin materials.

Immersion of the hot and cold cure denture lining materials in the sodium hypochlorite solution resulted in an insignificant increase in the surface hardness. Chau *et al.*[24] observed that sodium hypochlorite penetrated beyond the surface of the acrylic to a depth of 3 mm with ten minutes of immersion in a solution of 1% sodium hypochlorite. In addition, Miranda *et al*.[25] found that mouthwashes containing hydrogen peroxide and/or alcohol reduced the surface hardness of different resins by different immersion solutions. So we can concluded from the previous two studies that sodium hypochlorite could have had an effect on the surface hardness of the acrylic resin by opposing the effects of the reduction of the residual monomer and retarding the increase in surface hardness to an insignificant level. This also confirmed with the finding of Neppelenbroek *et al.*[26] who demonstrated a significant decrease in hardness after immersion in chemical disinfectant solutions, including sodium hypochlorite, regardless of material and disinfectant solution used. The results of their study showed that chemical disinfection with sodium hypochlorite adversely affected the surface hardness of denture base acrylic resin. They assumed that the sodium hypochlorite solution may have penetrated in to the tested materials and resulted in softening of the materials.

The hypothesis that the SOLO disinfectant solution could adversely affect the surface roughness of the different acrylic denture lining materials was rejected. The surface roughness was not affected for the samples of all the test groups. This was in agreement with the outcome of Ma *et al*.[8] who found that all denture acrylic resins tested could be immersed in some disinfectants for up to 30 minutes without appreciable alteration to surface texture. Also, da Silva *et al*.[9] stated in their study that immersion for 10 minutes produced no significant effect on the surface roughness of acrylic resin. However, this finding was in disagreement with the results of Machado *et al*.[12] who stated that immersion in a chemical disinfectant solution may increased the surface roughness of denture base acrylic resin and the findings of our study differed because of the short duration of immersion of the acrylic samples which may have not been enough to manifest any changes statistically.

In conclusion SOLO disinfectant solution could be used as a disinfection solution for hot and cold cure denture lining material as well as for soft acrylic resin lining material, since it had no adverse effect on the color stability, surface hardness, and surface roughness of these materials.

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Table 1: Experimental design for the test groups used in this study

Test groups	acrylic resin	Disinfectant solution
HA	Hot cure	Immersion in water for 10 min.
HB	Hot cure	Immersion in Sodium hypochlorite solution for 10 min.
HC	Hot cure	Immersion in SOLO solution for 5min.
CA	Cold cure	Immersion in water for 10 min.
CB	Cold cure	Immersion in Sodium hypochlorite solution for 10 min.
CC	Cold cure	Immersion in SOLO solution for 5min.
SA	Soft acrylic	Immersion in water for 10 min.
SB	Soft acrylic	Immersion in Sodium hypochlorite solution for 10 min.
SC	Soft acrylic	Immersion in SOLO solution for 5min.

Table 2: Mean and Standard Deviation for Color Stability

Test groups	Mean	Standard Deviation
HA_b	.91033	.086077
HA_a	.91800	.033451
HB_b	.93167	.065744
HB_a	.92833	.109418
HC_b	.79333	.033081
HC_a	.79500	.063836
CA_b	1.11200	.239217
CA_a	1.09667	.227280
CB_b	1.16033	.219751
CB_a	1.05833	.074568
CC_b	.98100	.045640
CC_a	.99767	.014468
SA_b	1.28067	.152762
SA_a	1.20900	.115013
SB_b	1.34400	.278253
SB_a	1.32233	.137293
SC_b	1.42300	.103131
SC_a	1.41833	.138500

(b) Before, (a) After

Table 3: Paired Sample T-Test of Color Stability

Test groups	Mean Diff.	Std. Deviation	Std. Error Mean	t	Sig.
HA_b-HA_a	-.007667	.070401	.040646	-.189	.868
HB_b-HB_a	.003333	.045092	.026034	.128	.910
HC_b-HC_a	-.001667	.031134	.017975	-.093	.935
CA_b-CA_a	.015333	.017502	.010105	1.517	.268
CB_b-CB_a	.102000	.145506	.084008	1.214	.349
CC_b-CC_a	-.016667	.036088	.020835	-.800	.508
SA_b - SA_a	.071667	.038188	.022048	3.250	.083
SB_b - SB_a	.021667	.316393	.182669	.119	.916
SC_b - SC_a	.004667	.035838	.020691	.226	.843

(b) Before, (a) After, * Significant $p < .05$, ** Highly significant $p < .01$

Table 4: Mean and Standard Deviation for Surface Hardness

Test groups	Mean	Standard Deviation
HA_b	6.03333	.030551
HA_a	3.98333	.086217
HB_b	4.32000	.020000
HB_a	4.17333	.155349
HC_b	8.04333	.058595
HC_a	4.47667	.222336
CA_b	5.46333	.098150
CA_a	5.05000	.045826
CB_b	4.03667	.063509
CB_a	3.65333	.571431
CC_b	4.33667	.317857
CC_a	4.16000	.144222

(b) Before, (a) After

Table 5: Paired Sample T-Test of Surface Hardness

Test groups	Mean Diff.	Std. Deviation	Std. Error Mean	t	Sig.
HA_b-HA_a	2.050000	.105357	.060828	33.702	.001(**)
HB_b-HB_a	.146667	.136137	.078599	1.866	.203
HC_b-HC_a	3.566667	.208167	.120185	29.676	.001(**)
CA_b-CA_a	.413333	.136137	.078599	5.259	.034(*)
CB_b-CB_a	.383333	.534634	.308671	1.242	.340
CC_b-CC_a	.176667	.461122	.266229	.664	.575

(b) Before, (a) After, * Significant p < . 05, ** Highly significant p < .01

Table 6: Mean & Standard Deviation of Surface Roughness

Test groups	Mean	Standard Deviation
HA_b	1. 38333	.382743
HA_a	1.94200	1.100768
HB_b	1.21633	.835685
HB_a	2.81100	1.827104
HC_b	.85500	.124048
HC_a	.81200	.012166
CA_b	2.27933	1.003071
CA_a	1.53567	.517355
CB_b	1.26433	.286280
CB_a	1.16000	.81854
CC_b	1.39067	.625574
CC_a	1.11533	.922042
SA_b	2.64800	.328827
SA_a	2.89567	1.924886
SB_b	1.94300	.649023
SB_a	1.67100	.708420
SC_b	2.36067	1.508769
SC_a	5.52100	.197302

(b) Before, (a) After

Table 7: Paired Sample T-Test for Surface Roughness

Test groups	Mean Diff.	Std. Deviation	Std Error Mean	t	Sig.
HA_b-HA_a	-,558667	1.252481	.723120	-,773	.521
HB_b-HB_a	-1.594667	1.397909	.807083	-1.976	.187
HC_b-HC_a	.043000	.114053	.065848	.653	.581
CA_b-CA_a	.743667	.493919	.285164	2.608	.121
CB_b-CB_a	.104333	.368058	.212498	.491	.672
CC_b-CC_a	.275333	.728300	.420484	.655	.580
SA_b - SA_a	-,247667	1.673500	.966196	-,256	.822
SB_b - SB_a	.272000	1.205241	.695846	.391	.734
SC_b - SC_a	-3.160333	1.681604	.970875	-3.255	.083

(b) Before, (a) After, * Significant p < . 05, ** Highly significant p < .01