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The Effect of Commonly Available Denture Cleansers on Surface Hardness and Roughness of An Acrylic-Based Soft Liner

Hamzah Kareem Rustam^{(1)*}
Luma M. Al-Nema⁽²⁾

^(1,2) Department of Prosthodontics, College of Dentistry, Mosul, Iraq.

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*Corresponding Author:

Email:

hamzahdent89@gmail.com
Department of
Prosthodontics, College of
Dentistry, Mosul, Iraq.

Abstract

Introduction: disinfection of dentures and soft denture liners was prioritized for cross-contamination management and patient safety. However, it has been shown that these approaches have an influence on the physical and mechanical qualities of denture liners. Objective: assessment of the effect of disinfection by sodium hypochlorite and cleansing tablet on surface hardness and roughness of an acrylic-based soft liner. Material and Methods: 15 specimens were prepared for each test, and then divided into three groups (2% NaOCl, Protefix tablet, and control). The specimen's preparation was done by conventional procedures according to manufacturing instructions. The daily disinfection of specimens was continued for 30 days. After each immersion in a denture cleanser, distilled water was used to maintain the specimens at room temperature. Hardness and roughness measurements were made by shore A durometer and profilometer devices respectively and the results were analyzed by ANOVA test. Results: there were no significant differences in the hardness value between the examined groups, with the high mean value obtained with the cleansing tablet group, whereas the low value was obtained in the control group. When compared to the control group, the soft-liner increased surface roughness significantly in the NaOCl group, but just slightly and not significantly in the cleaning tablet group. Conclusion: the denture cleansers employed in this investigation had no significant effect on the soft liner's hardness. When compared with a control group, sodium hypochlorite significantly increased the surface roughness of the soft liner, while the cleansing tablet was not significantly affected the surface smoothness.

Introduction:

Soft denture liners can be used to help individuals who are unable to withstand denture pressures due to thin, sharp, excessively resorbed ridges, acquired and congenital palatal deformities, and extensive bony undercuts (1). Resilient liners exhibit issues such as deterioration of the bond strength, color changes, porosity, and loss of resilience throughout clinical use, some of these disadvantages promote microbial growth and affect the liner's lifetime as well as oral health conditions like denture stomatitis (2,3). Denture plaque management utilizing mechanical and chemical treatments is critical for denture users to maintain proper oral hygiene. Mechanical scrubbing is not advised for resilient denture liners due to the risk of damaging the resilient lining material. The chemical denture cleansers are preferred for eliminating plaque from dentures (4,5). However, Water sorption, solubility, Hardening, porosity, and color change are the most prevalent problems raised while utilizing denture cleaners. Hygiene methods have been observed to affect the physical and mechanical qualities of denture liners by causing plasticizer and soluble ingredient loss (5). So, the aim of the current study is to assess the influence of widely available denture cleaners on the hardness and roughness parameters of permanent soft acrylic liners.

Materials And Methods

Specimens processing:

A total of 30 samples were made; 15 specimens for hardness measurement with dimensions (30mm and 3mm in diameter and thickness respectively) (6,7) and 15 specimens for surface roughness measurement with dimensions (10mm length, 10mm width, and 3mm thickness) (7,8). modeling wax with specific measurements for each test was invested in a dental stone for mold creation Fig. (1). After wax elimination was done, the acrylic-based soft liner (Vertex-Soft, Netherlands) was mixed at a 2g powder to 1ml liquid ratio (manufacturer's guidelines), When the material reached the

dough stage, it was loaded into the stone mold that had been made after the wax was removed. The flask parts were restored to their original locations and pressed for 5 minutes under the hydraulic press (9). The resilient liner specimens were polymerized using a water bath according to the manufacturer's recommendations (70 °C for 1.5 hours, then 100 °C for 30 minutes). And the flask was bench-cooled for 20 minutes before opening (10). The samples were then taken out of the mold, and the unnecessary edges were cut by using a surgical blade (11). All of the samples were separated into three groups as shown in Table (1).

Disinfection procedures of the samples

After 30 days, specimens of all three groups were evaluated, and the methodology was designed to mimic the patients' regular usage of dentures.

- Group A (control group): The samples were submerged in distilled water.
- Group B (sodium hypochlorite group): The samples were soaked in a 2% NaOCl solution (Microvem, Turkey) for 10 minutes every day. This percentage had been used to clean soft liners (12).
- Group C (cleansing tablet group): One cleansing tablet (Protefix Active Cleanser, Flensburg-Germany) was dissolved in 200ml of warm water (35°C), and the samples were immersed for about 10 minutes per day for disinfection, as indicated by the manufacturer. Sodium Bicarbonate, Potassium Caroate, and Sodium Carbonate are considered from its ingredients.

Throughout the investigation, the specimens were stored at room temperature (13). The samples were disinfected every day for 30 days, then washed under tap water and preserved in distilled water. New denture cleaner solutions were given for every disinfection cycle, and the distilled water was replaced daily (10).

Indentation Hardness test: The hardness test was performed using a Shore A

durometer (Digital display Hardness Tester, HS-A, China). A distance of 20mm was set between the specimen and the durometer's indenter, with a touching period of 5 seconds following penetration. According to the device's instructions, the specimen was put firmly on a smooth table. Then the hardness value of soft liner samples was determined by using the average of five individual measurements (10,14).

Surface roughness test: A profilometer device (TR 200, Germany) was used to assess surface roughness at 0.5mm/second speed and a cut-off length of 5mm. The surface analyzer provides the instrument to trace the profile of surface irregularity and register all recesses and peaks through the needle traversing a cross surface. After calibrating the instrument according to the manufacturer's specifications, three measurements were taken at different locations on the surface of the sample, and the mean value for each specimen's surface roughness (Ra μm) was calculated (15).

Results

Table (2) shows the mean values and standard deviations for the soft-liner specimens for each hardness and surface roughness after 30 days of regular disinfection.

Indentation Hardness: Table (3) displays the descriptive statistics of the hardness value (shore A value) for cleansed and control soft liners with a greater value shown in the cleansing tablet group (61.8), while the control group had a lower value (58.4). According to the result of the Shapiro-Wilk analysis, the hardness values in the investigational groups had a normal distribution ($P > 0.05$). Table (4): Analysis of variance (ANOVA) found no significant differences between the examined groups ($P > 0.05$). Fig. (2) shows the results of Duncan's multiple range tests for the influence of different disinfectants on the hardness value of the soft liner after 30 days, which revealed no significant difference between the study groups.

Surface Roughness:

The descriptive statistics for surface roughness (μm) for controlled and disinfected soft liner were seen in Table (5), confirming that the control group has the lowest mean roughness value (1.78 μm) and the largest mean value for surface roughness is obtained in the 2% sodium hypochlorite group (2.2696 μm). According to the result of the Shapiro-Wilk analysis, the surface roughness values in the investigational groups had a normal distribution ($P > 0.05$). Table (6): Analysis of variance revealed highly significant differences between the groups studied ($P < 0.01$). Duncan's multiple range tests for the impact of different cleaning agents on the roughness value of the soft liner after 30 days are shown in Fig. (3), which demonstrated that the cleansed soft liner with 2% sodium hypochlorite solution was significantly increased in surface roughness value (2.2696 μm) in comparing to a soft liner immersed in distilled water (1.78 μm), and protefix tab cleansing tablet (1.7978 μm). No significant difference was found between the soft liner immersed in distilled water and that cleansed with Protefix tablet.

Discussion

Hardness test

Hardness is a necessary characteristic of resilient materials and should stay consistent throughout time, depending on whether the material is permanent or temporary, so that the material could perform its function efficiently (12). The change in hardness qualities of soft liners is influenced by a number of elements, including immersion time, pH and surroundings temperature, liquid type, concentrate, and cleanser composition (11).

Denture cleaning impacts the qualities of soft lining materials, lowering their elastomeric properties; acrylics were more negatively affected than silicone. These alterations are caused by the loss of different compounds from soft lining substances, such as plasticizers and monomers (5). This agrees with the results of this study that after 30 days of regular cleansing, the soft liner explained a slight

increase in the hardness value, the control group had a lower shore A value (58.4 Shore) and the Protefix tablet group had a higher value (61.8 Shore).

And it was also stated in the previous study that the quantity of discharged components varied depending on the type of cleaning agent used (20).

The findings of this study correspond with a previous study by Pahuja *et al.* (2013) (4) who observed that the shore A value of the acrylic resilient liner increased in the sodium hypochlorite and sodium perborate groups as compared with control.

Also, in accordance with a previous study by Mohammed *et al.* (2016) (5) who found that the hardness of self-cured acrylic and silicone resilient liners increased in value while submerged in cleansing tablets.

In a previous study by Narwal (2015) (21) the findings agreed with the result of this research when he found that prolonged submerge in denture cleansing solutions increased the hardness value of the soft liners utilized.

Nakhaei *et al.* (2019) (10) demonstrated in a previous study the effect of 0.5% NaOCl, Corega tabs, and ozonated water on the surface hardness of a silicone-type soft liner and discovered that the lowest mean shore A value with the cleansing tablets was significantly different from the NaOCl and control groups, which disagree with the findings in this study, while the effect of NaOCl was consistent with our findings. However, there are variations between the two experiments in terms of the type of cleaning tablets, sample sizes, the concentration of NaOCl, storage durations, and storage temperatures.

Roughness test

Surface roughness encourages microbial adherence, which is the preliminary stage in the colonization and growth of mouth pathogens in denture users (13). Because surface roughness is one of the issues connected with using liners, soft liner material was the first stage in the development and even colonization of oral diseases in denture users, as a result, these materials should be present as much as feasible with low surface roughness in order to minimize biofilm development and oral mucosal irritation (17). The

roughness value of all disinfected soft liners was increased. When compared to the control, it was non-significant when a cleaning tablet was used but it was significant when 2% NaOCl was employed Fig. (3). Although chemical denture cleaners are regarded to be an efficient way to avoid *Candida albicans* colonization and biofilm development, it is widely stated that everyday use of a denture cleaning can impair the qualities of the denture acrylic and the soft liners (18).

It was detected that the surface roughness of the acrylic resilient liner increased significantly after soaking in denture cleaning. The roughness of Acrylic-Based soft liner may have increased due to the likely loss of constituents, such as plasticizers, creating empty spaces. These empty gaps are most likely responsible for the roughness and growth in size that results in craters over time. Surface disturbances also can be linked to lining porosity. During mixing, the air is trapped, and it seems that some of the cleaners make the bubbles enlarged, with some of them reaching the surface (5).

Also, it was stated in a previous study that after immersing resilient liner in a cleansing tablet, the surface roughness increased, which might be attributed to the loss of plasticizer, alcohol, and water absorption (15).

The results were supported by Mohammed *et al.* (2016) (5) who discovered that immersing the acrylic soft liner in denture cleaners increased the average roughness value.

Also, the results agree with a previous study by Usta Kutlu *et al.* (2016) (15) who found an increase in the surface roughness value of soft liner after immersion in the cleansing tablet.

In contrast to a previous study by Garcia *et al.* (2003) (19), who found that when resilient liner samples were submerged in Polident solution, the surface roughness was unaffected. And immersed samples had a significantly lower roughness value than those submerged in water, these variations might be attributed to the use of various types of soft liners, polymerization methods, preparation methods, storage

media and temperature, immersion period, and immersion time.

Conclusions:

The increase was not significant in the surface hardness of the soft liner samples when cleansed with both Protefix tabs and 2% sodium hypochlorite. The surface

smoothness of the resilient liner was not significantly affected when immersed in the Protefix cleaning tablet, while the increase in surface roughness of the acrylic soft liner was significant when immersed in a solution of 2% sodium hypochlorite.



Fig. (1): Modelling wax investment in different sizes in the lower halves of the flasks to make a specific mold for hardness and roughness tests.

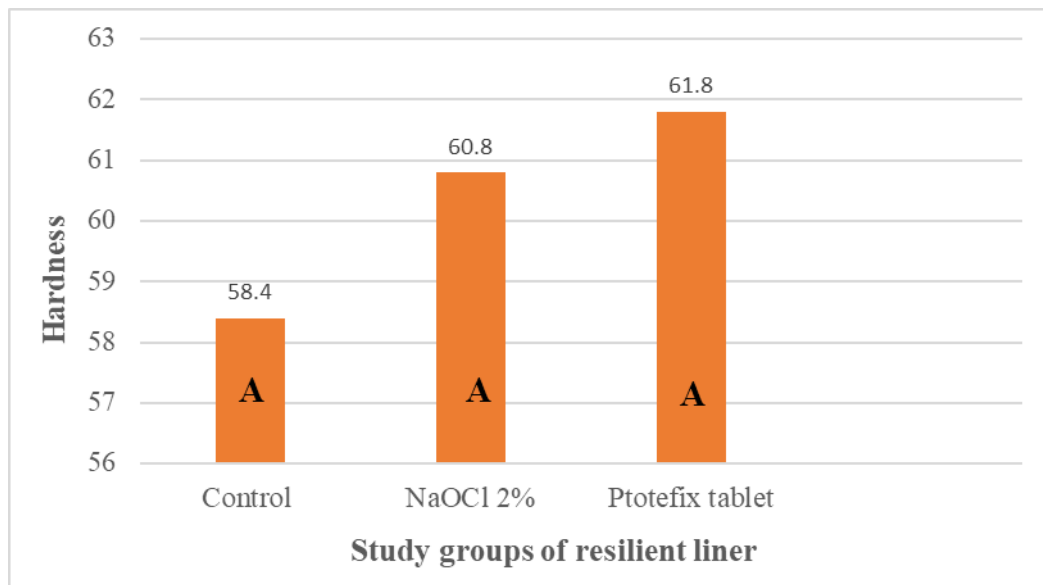


Fig. (2): Duncan's multiple range test for disinfected soft liner hardness after 30 days.

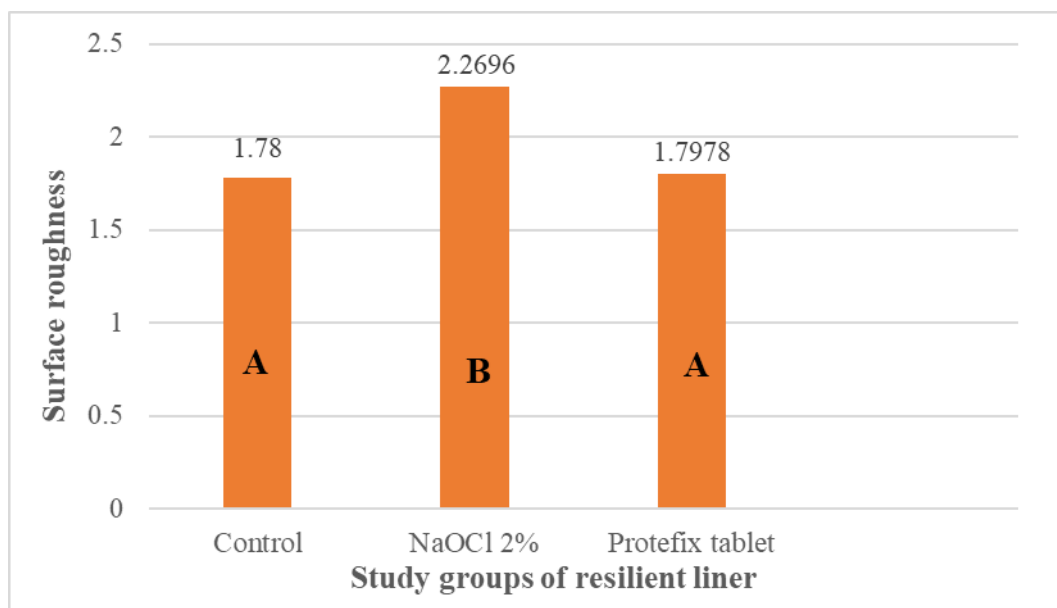


Fig. (3): Duncan's multiple range test for surface roughness of disinfected soft liner after 30 days.

Table (1): Grouping of the samples.

	Hardness	Surface roughness
Study groups	Number of specimens	Number of specimens
Group A (control group)	5	5
Group B (2% NaOCl)	5	5
Group C (cleansing tablet group)	5	5
Total of the samples	15	15

Table (2): Shows the mean values and standard deviations for the soft liner specimens for each hardness and surface roughness after 30 days of regular disinfection.

Study groups	Surface hardness			Surface roughness		
	N	Mean value	Std. Deviation	N	Mean value	Std. Deviation
Group A (Control)	5	58.4 Shore	2.19089	5	1.78 μm	0.01158
Group B (NaOCl 2%)	5	60.8 Shore	2.38747	5	2.2696 μm	0.06349
Group C (Protefix tablet)	5	61.8 Shore	3.83406	5	1.7978 μm	0.01006

N: Number of samples.

Table (3): Descriptive of the hardness of control and disinfected resilient liner.

Study groups	Number of samples	Min.	Max.	Mean	Std. Error	Std. Deviation
Group A (Control)	5	55	61	58.4	0.97980	2.19089
Group B (NaOCl 2%)	5	58	64	60.8	1.06771	2.38747
Group C (Protefix tablet)	5	57	66	61.8	1.71464	3.83406

Table (4): Analysis of variance of shore A comparison of control and disinfected groups.

Source of Variance	Sum of Squares	df	Mean Square	F	Significance
Between Groups	30.533	2	15.267	1.817	0.204
Within Groups	100.800	12	8.400		
Total	131.333	14			

df: Degree of freedom; F: F Value.

Table (5): Descriptive statistics for surface roughness (μm) of the control and disinfected soft liner.

Study groups	Number of samples	Min.	Max.	Mean	Std. Error	Std. Deviation
Group A (Control)	5	1.77	1.80	1.78	0.00518	0.01158
Group B (NaOCl 2%)	5	2.21	2.36	2.2696	0.02839	0.06349
Group C (Protefix tablet)	5	1.79	1.82	1.7978	0.00450	0.01006

Table (6): Analysis of variance of surface roughness of control and disinfected groups.

Source of variance	Sum of Squares	df	Mean Square	F	Significance
Between Groups	0.771	2	0.386	271.109	0.000
Within Groups	0.017	12	0.001		
Total	0.788	14			

df: Degree of freedom, F: F Value.

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