Effect of denture cleansers on surface hardness of resilient denture liners at various time intervals- an *in vitro* study

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PURPOSE. This study was aimed to determine the effect of two chemically distinct denture cleansers and water on the surface hardness of acrylic and silicone based soft denture liners at various time intervals. **MATERIALS AND METHODS.** Two commonly used commercial resilient liner material were selected based on their chemical composition (silicone- and acrylic-based soft liners) for this investigation. 120 cylindrical specimens were made of 15 mm × 10 mm dimensions (according to ASTM: D-2240-64T) in a custom made metal mold. All specimens were stored in artificial saliva throughout the study. Forty specimens were cleansed daily in 0.5% sodium hypochlorite solution; forty were cleansed in sodium perborate and remaining forty specimens were daily rinsed in water. Testing was done at 1 week, 1 month, 3 months and 6 months for surface hardness using a Shore A Durometer. A mean of 3 reading for each sample was subjected to one-way ANOVA, Post Hoc test and pair-t test for statistical analysis. *P* values of less than 0.05 were taken as statistically significant. **RESULTS.** Surface hardness of all the samples was significantly higher after a period of 6 months irrespective of the cleansing treatment. Minor changes were observed between control, sodium hypochlorite and sodium perborate groups with time. Greater change was observed in surface hardness of acrylic-based soft denture liners as compared to silicone-based soft liners for all groups, as time progressed. **CONCLUSION.** Silicone-based soft denture liners performed significantly better in all cleansing treatments than acrylic-based soft denture liners ***[J Adv Prosthodont 2013;5:270-7]***

KEY WORDS: Soft denture liners; Denture cleansers; Surface hardness; Sodium hypochlorite; Sodium perborate

INTRODUCTION

Certain parts of the alveolar ridge are sensitive to the pressure of hard prosthetic materials, due to thin overlying mucosa.[1] When the shock absorbing behaviour of mucosa is diminished, masticatory impact forces are directly transmitted to the underlying tissue. As a result, there is an increased burden on the residual ridges.[2] Soft lining materials are able to form an absorbing layer on the part of denture in contact with the oral mucosa and this allows less traumatic occlusal force transmission.[1] These properties make soft denture lining materials useful for treating patients with ridge atrophy or resorption, bony undercuts, bruxing tendencies, congenital or acquired oral defects, xerostomia and dentures opposing natural dentition.[3] The result is that wearing the complete prosthesis becomes more comfortable for the patient.

Contemporary elastic materials are used for short and long term application in the oral cavity and are divided into acrylic and silicone types. Depending upon polymerization techniques, these can be further divided into room temper-

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ature and high temperature polymerizing resilient denture liners.[1] The resilient lining materials present problems during clinical use, such as weakening of bond between lining and denture, loss of resiliency, colour alterations, and porosity. The loss of resiliency may be due to the leaching out of the plasticizer and other components.[4] Simultaneously water is absorbed until equilibrium is reached thereby, increasing surface roughness of the resilient denture liners.[5] It has been seen that rougher surfaces enhance adhesion of microorganisms onto resilient lining materials and may allow fungal growth.[6] Patients using removable prosthetic restorations lined with an elastic material should, therefore, carry out regular cleansing procedures to prevent such infection.[1]

Denture plaque control using mechanical and chemical methods is essential for maintenance of good oral hygiene of denture wearers.[7] However, mechanical cleansing (brushing) is not advisable for soft denture liners since it can damage the resilient lining.[8] Chemical cleansing by denture cleansers is the first choice for denture plaque control of tissue conditioners.[7]

The solutions used for denture cleaning can be divided according to their chemical composition: alkaline peroxide, alkaline hypochlorites, acids, disinfectants and enzymes. Peroxide cleansers are the most commonly used denture cleansers.[9] They are dispensed in powder or tablets forms, which become alkaline solutions of hydrogen peroxide when dissolved in water.[10] Hypochlorites are useful as denture cleansers because they remove stains, dissolve mucin and other organic substances and are bactericidal and fungicidal.

This study was aimed to determine the effect of two chemically distinct denture cleansers and water on the surface hardness of acrylic and silicone based soft denture liners at various time intervals.

MATERIALS AND METHODS

The study was conducted in Maharishi Markandeshwar College of Dental Sciences and Research, Mullana, Ambala, Haryana, India. Two commonly used commercial resilient liner materials, based on their chemical composition (silicone- and acrylic-based soft liners) were selected for the study. The resilient lining materials and denture cleansing agents used are listed in Table 1. Total of hundred and twenty cylindrical specimens were made of the dimensions 15 mm × 10 mm (according to ASTM: D-2240-64T)[3] with the help of a custom made metal mold (Fig. 1). Petroleum jelly was applied on the mold for easy removal of the specimens. Base of the mold was placed on a glass slab covered with cellophane sheet to facilitate separation of mold from the glass slab. Soft denture liners were manipulated according to manufacturer's instructions and expressed into the mold (Fig. 2). The mold was then covered from the top by a cellophane sheet and another glass slab was pressed tightly against the mold to remove excess material and to shape the specimens according to the dimensions of the mold. Once the material was set, the specimens were removed from the mold and excess was trimmed using a BP blade.

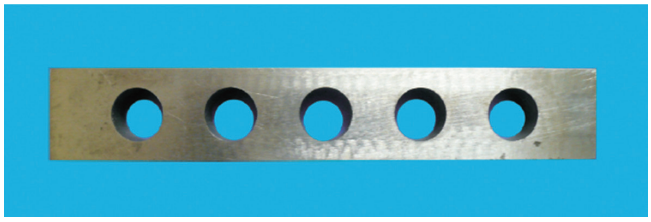

Fig. 1. Custom made metal mold.

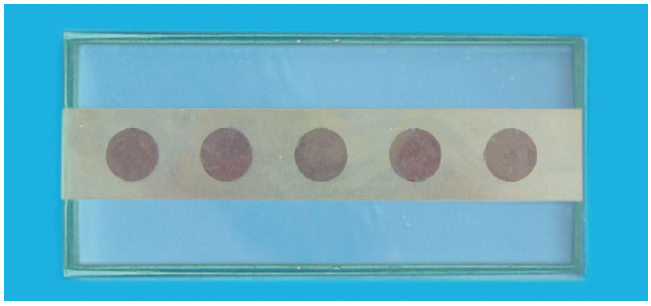

Fig. 2. Fabrication of samples.

Table 1. Materials used in this study

Material	Product	Manufacturer
Autopolymerizing silicone-based resilient liner	Mollosil LOT No. 150301	Detax, Ettlingen, Germany
Autopolymerizing acrylic-based resilient liner	Permasoft denture liner LOT No. 121102C	Dentsply Ltd., Delhi, India
5% sodium hypochlorite solution	5% sodium hypochlorite in a dilution of 1:10 (Batch No. 1852011201)	Alpha- Chem, Ambala, India
Sodium perborate denture cleanser	Fitty Dent super cleansing tablets (Batch No. FOT11062)	Dr. Reddy's Laboratories Ltd., Hyderabad, India

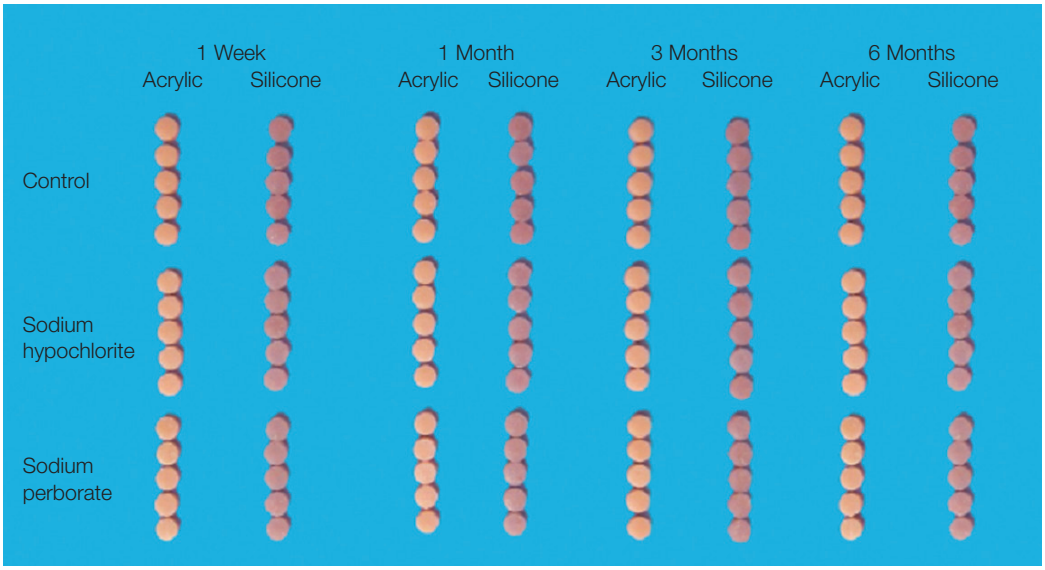

Fig. 3. Grouping of sample.

Table 2. Grouping of specimens for the evaluation of surface hardness

Groups	Subgroups								Total
	I (1 week)		II (1 month)		III (3 months)		IV (6 months)		
Minor subgroups	Ia	Ib	IIa	IIb	IIIa	IIIb	IVa	IVb	
A (Control)	5	5	5	5	5	5	5	5	40
B (Sodium hypochlorite)	5	5	5	5	5	5	5	5	40
C (Sodium perborate)	5	5	5	5	5	5	5	5	40

All specimens were stored in artificial saliva throughout the study.

All specimens were divided into three major groups based on cleansing treatments. Group A (control), Group B (sodium hypochlorite) and Group C (sodium perborate) comprising of 40 specimens each (Fig. 3). Each group was divided further into 4 subgroups: Subgroup I, II, III and IV (consisted of 10 specimens each) to be tested at a time interval of 1 week, 1 month, 3 months and 6 months respectively. Each subgroup was again divided into two minor subgroups: Minor Subgroup a - consisted samples made of acrylic based soft denture liner and minor Subgroup b - consisted of samples made of silicone based soft denture liner (Table 2).

All specimens were cleansed daily. Specimen in Group A (control) were cleansed daily by rinsing with water and then were stored in artificial saliva for the entire period of the study.

Specimens in Group B were immersed in 0.5% sodium hypochlorite solution for ten minutes daily, rinsed in water and stored in artificial saliva at room temperature.

Specimens in Group C were cleansed in a solution of sodium perborate denture cleansing tablets (dissolved in 250 mL water as recommended by the manufacturer). Specimens were then rinsed in water and stored in artificial saliva at room temperature.

Specimens of all 3 groups were tested at 1 week, 1 month, 3 months and 6 months time interval at Central Institute of Plastics Engineering & Technology (CIPET), Panipat, Haryana. The specimens were tested using a Shore A Durometer which was calibrated in accordance with ASTM D-2240 under the spring force of 822 gf (8.06 N) (Fig. 4). Three readings were noted for each sample and the mean of those readings was taken (Table 3). These readings were then subjected to one-way ANOVA, post hoc test and pair-*t* test for statistical analysis.

Fig. 4. Shore A Durometer.

RESULTS

Insignificant differences were observed in mean values of surface hardness of samples for all groups after 1 week. After 1 month highly significant changes were noted in surface hardness for acrylic samples when mean values for control group are compared to those of sodium hypochlorite group and sodium perborate group. Insignificant differences were seen in mean values between sodium hypochlorite and sodium perborate group. For silicone samples insignificant differences were seen in mean values of surface hardness between all groups at 1 month. At 3 months insignificant differences in mean values of surface hardness were seen for all groups. At 6 months insignificant differences in mean values of surface hardness of samples were seen for acrylic samples. For silicone based soft denture liners insignificant differences were seen in mean values of surface hardness of samples for all groups except between sodium hypochlorite and control group, which showed highly significant difference in mean values (Table 4).

In control group differences seen in mean values for surface hardness of acrylic samples at all time intervals were very significant, except between 1 week and 1 month. Also highly significant changes were noted for mean values of surface hardness of acrylic samples at all time intervals in sodium hypochlorite and sodium perborate group (Table 5).

Table 3. Test results for Shore A Hardness

Groups	1 week		1 month		3 months		6 months	
	A*	S†	A*	S†	A*	S†	A*	S†
Control	19	21	24	25	37	25	51	29
	21	22	24	22	42	22	52	28
	18	23	22	26	38	23	51	28
	19	19	22	25	38	22	52	27
	19	20	22	25	47	26	51	30
Sodium	16	21	35	25	39	25	52	31
hypochlorite	17	20	31	21	38	29	53	33
	19	21	29	25	38	24	50	30
	19	21	29	24	40	26	52	30
	18	22	28	24	40	25	53	33
Sodium	18	20	31	24	45	25	53	29
perborate	18	20	33	24	40	25	51	30
	17	19	30	23	40	27	52	32
	20	22	30	22	38	26	51	30
	20	21	30	23	38	24	51	30

* acrylic based soft liners
† silicone based soft liners

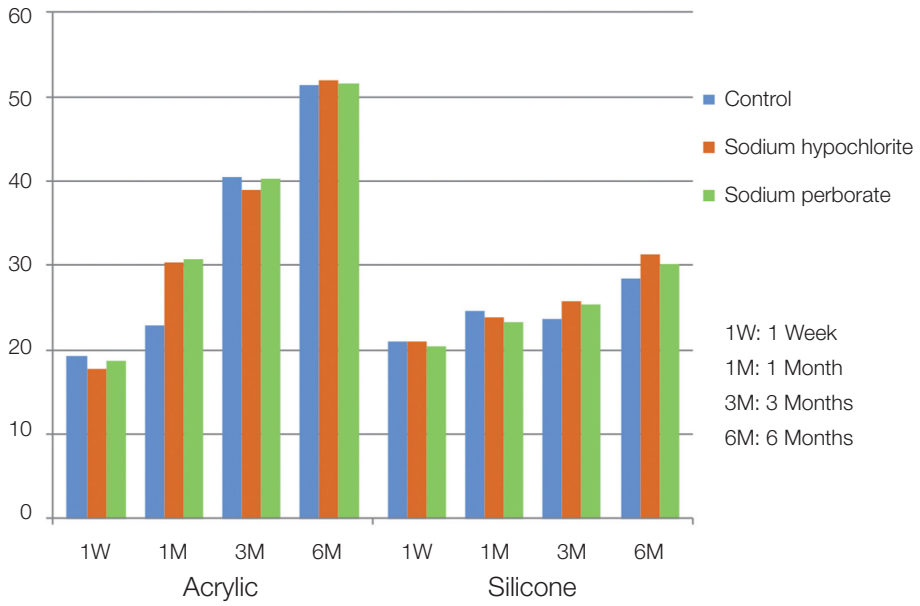

Table 4. Comparing mean values of acrylic- and silicone-based soft denture liners at various time intervals in all groups.

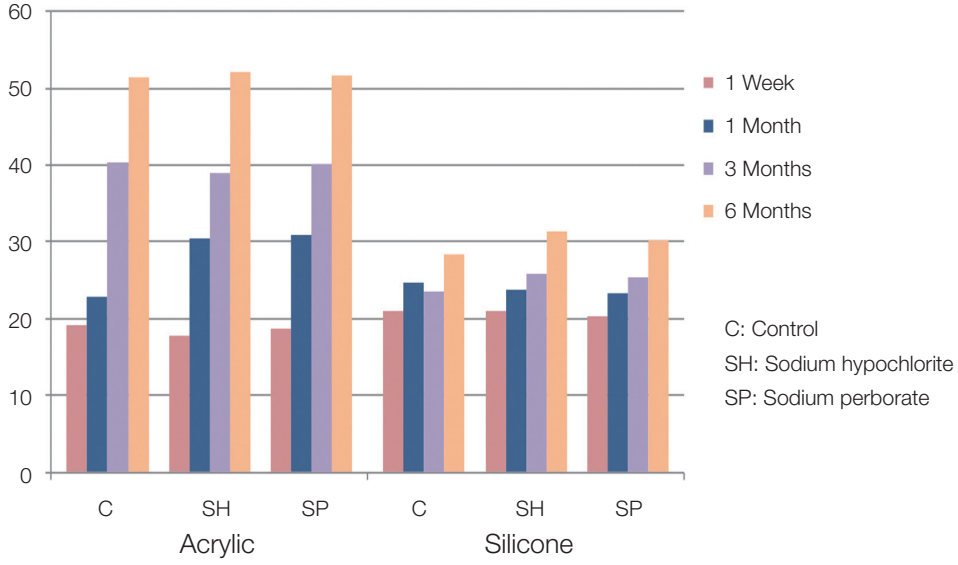

Table 5. Comparing effect of different cleansing solutions on mean values of acrylic- and silicone-based soft denture liners at various time intervals.

Silicone samples in control group showed no significant differences in mean values for surface hardness between 1 week, 1 month and 3 months. Highly significant differences were seen between means of 6 months when compared to 1 week, 1 month and 3 months. In sodium hypochlorite group, differences in mean values were insignificant between 1 week and 1 month, and 1 month and 3 months. Highly significant differences were seen between 1 week and 3 months. At 6 months, results were highly significant in comparison to 1 week, 1 month and 3 months. In Sodium perborate group mean values for silicone samples showed insignificant differences between 1 week and 1 month. Statistically significant differences were seen in mean values between all other time intervals (Table 5).

Comparative evaluation between silicone and acrylic samples revealed insignificant differences in mean values for surface hardness of acrylic-based and silicone-based soft denture liners in control group at 1 week. At 3 months and at 6 months highly significant differences were seen in mean values of acrylic-based and silicone-based soft denture liners in all groups indicating much better performance of silicone-based soft liners after 6 months (Table 6).

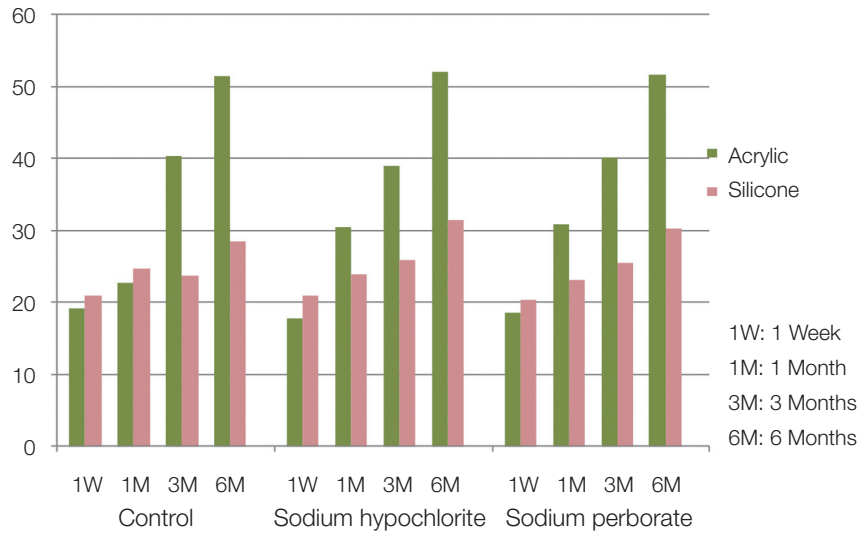

Table 6. Comparison between mean values of acrylic and silicone based soft denture liners at all time intervals in all groups.

DISCUSSION

Currently the most commonly used materials are plasticized acrylics and silicone rubber which are either chemically or heat polymerized.[10] Silicone rubber material is composed of dimethyl siloxane polymer which is a viscous liquid, cross linked to provide good elastic properties. These materials excel in their resiliencies, whereas, acrylic soft resin materials are acrylic co-polymers to which plasticizers may be added. These materials may absorb water, swell and harden because of plasticizer leaching.[11] This hypothesis is supported by Hadary and Drummond[12] who evaluated two soft denture lining materials with distinct chemical composition to determine whether compositional variations manifest themselves in property differences. The results revealed that acrylic-based soft liner had higher solubility and sorption than silicone-based and on this basis concluded that silicone based products may provide better clinical success.

Denture plaque control using mechanical and chemical methods is essential for maintenance of good oral hygiene of denture wearers. It has been reported that soft denture liners can be deeply penetrated by *Candida albicans*.[6] Brushing (mechanical plaque control) is not advisable for resilient denture liners, because it can damage the resilient lining.[9] Furthermore, ultrasonic treatment is not effective for removal of denture plaque[7]. This is supported by Hermann *et al.*[13] who in their study observed that mechanical brushing promoted wear abrasion of soft liners. Only chemical treatment by denture cleansers can be applied to such soft material.[6]

Alkaline peroxide (or sodium perborate) and sodium hypochlorite denture cleansers are the most commonly used denture cleansers. Alkaline peroxide cleansers are commercially available as powder or tablets which become alkaline solutions of hydrogen peroxide when immersed in water. Saraç *et al.*[14] studied the effectiveness of denture cleansers on soft denture liners and concluded that sodium perborate denture cleanser proved to be most effective. Hypochlorites are known to have bactericidal and fungicial property and act on stains, dissolve mucin and other organic substances.[10] de Freitas Fernandes *et al.*[15] and Ferreira *et al.*[16] in their study concluded that the best results were found for the treatment with 0.5% NaOCl for 10 minutes in comparison to other cleansers.

The present study was conducted for determining and comparing surface hardness of one silicone-based and one acrylic-based soft denture liner over a period of 6 months when cleansed daily.

In control group, silicone-based soft denture liners have shown a few changes in surface hardness for the first 3 months but highly significant changes were observed in surface hardness at 6 months, whereas, acrylic-based soft denture liners showed minor changes in surface hardness for 1 month, after which they showed significant increase in surface hardness at all time intervals. These results are supported by Mese and Guzel[5] who evaluated the effect of storage duration on the hardness and tensile bond strength of 2 acrylic resin-based and 2 silicone-based resilient liners. They concluded that after 6 months hardness values of all resilient liners evaluated were higher with increased duration of immersion. The hardness values of acrylic resin-based liners showed greater change than those of silicone products.

In sodium hypochlorite group, highly significant

increase in surface hardness was noticed for acrylic samples for all time intervals. In case of silicone samples, increase in surface hardness was insignificant between 1 week and 1 month, and 1 month and 3 months, however, highly significant changes were seen between 1 week and 3 months. At 6 months results were highly significant in comparison to 1 week, 1 month and 3 months. In sodium perborate group, acrylic-based soft liners showed highly significant increase in surface hardness at all time intervals. In case of silicone samples insignificant changes were noticed between 1 week and 1 month. Highly significant increase in surface hardness was seen at all other time intervals

At 1 week, all samples showed insignificant change in surface hardness for control, sodium hypochlorite and sodium perborate group.

At 1 month sodium hypochlorite and sodium perborate were seen to have highly significant affect on surface hardness of acrylic samples as compared to control group, whereas, silicone based soft liners showed insignificant changes in surface hardness in control, sodium hypochlorite and sodium perborate group. This result is supported by the findings of Brożek *et al.*[1] who determined the effect of storage in disinfectants and artificial saliva on a series of commercial soft lining materials for dentures. It was observed that the acrylic materials became less elastic on storage for up to 28 days whereas the silicone materials showed no change in elastic properties, irrespective of cleansing treatment.

At 3 months, no significant change was seen in surface hardness values of acrylic and silicone samples for control, sodium hypochlorite and sodium perborate group, but at 6 months sodium hypochlorite has shown highly significant increase in surface hardness of silicone samples in comparison to control group, whereas, sodium perborate has not shown any significant changes in comparison to control group and sodium hypochlorite group. In case of acrylic based soft denture liners, the results showed no significant changes in surface hardness, irrespective of cleansing treatment. These results are supported by Goll *et al.*[17] who in their study concluded that sodium hypochlorite denture cleansers caused more damage to surface properties of soft liners than sodium perborate denture cleansers. The present study is also in accordance with the study conducted by Mante *et al.*[18] who evaluated *in vitro* changes in hardness of four sealed resilient lining materials and revealed that immersion in alkaline peroxide denture cleanser showed only a mild effect on the hardness of the soft reline agents.

Acrylic based soft liners showed highly significant increase in surface hardness than silicone-based soft liners for sodium hypochlorite and sodium perborate groups, but, no significant differences were observed for control group at 1 week and 1 month. After 3 months and 6 months, among both the soft liners tested in the study, silicone -based soft liners performed significantly better than acrylic-based soft liners for all groups. Similar results were obtained in study by Mancuso *et al.*[19] tested hardness and color stability of liner materials based on acrylic resin and silicone after 2000 thermal cycles. It was concluded that hardness of silicone soft liners was less affected than acrylic resin-based liners.

All the materials tested in the study showed an increase in surface hardness with time irrespective of the cleansing method. However, no significant difference was observed among control, sodium hypochlorite and sodium perborate groups. Overall results indicated that silicone-based soft denture liners performed significantly better than acrylic-based soft denture liners. The present study was an *in vitro* study. The soft denture liners are meant to function with denture in the oral cavity. The nutrient-rich environment of the oral cavity does not fully match the *in vitro* nature of the present study. Therefore, the behavior of denture lining materials in this study may only partially predict the clinical performance. Despite increasing usage of soft liners in prosthetic dentistry and the importance of cleansing to prevent cross contamination, factors such as absorption and solubility, roughness, bond strength, color stability and viscoelastic properties need to be further investigated to define the best cleansing procedure for these materials.

CONCLUSION

Within the limitations of this study, it can be concluded that chemical denture cleansers can be used daily to cleanse soft denture liners without adversely affecting their surface hardness. Silicone-based soft liners showed better compatibility with cleansing solutions and maintained their resiliency better thereby, proving to be more promising for long term usage.

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