

# THE COMPATIBILITY OF DENTURE CLEANSERS AND RESILIENT LINERS

## INFLUÊNCIA DOS AGENTES QUÍMICOS DE LIMPEZA SOBRE REEMBASADORES RESILIENTES DE PRÓTESES

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### ABSTRACT

**P**urpose: Difficulty in cleaning resilient denture liners remains a material disadvantage. The purpose of the present study was to evaluate the effect of denture cleansers on hardness of resilient liner materials. Materials and Methods: Three resilient liners, Luci Sof<sup>®</sup> (Dentsply), Molloplast-B<sup>®</sup> (Dentax), and Sofreliner<sup>®</sup> (Tokuyama), and two denture cleansers, Efferdent<sup>®</sup> (Warner-Lamber), and 0.5% alkaline hypochlorite preparation were used. Twenty specimens of each material were prepared, measuring 25X15X3mm. Two denture cleansing approaches were used: 1) alkaline hypochlorite, for 20 minutes; 2) alkaline peroxide, for 30 minutes. This procedure was repeated 8 times a day, during 90 days. The specimens were evaluated before and after 360 and 720 cycles, to simulate 1 and 2 years of clinical cleaning procedures, respectively. The Shore A hardness was evaluated in a durometer (Teclock GS-709A), with a penetrating load of 10N for 1 second. Any macroscopic changes, such as loss of color or alteration in surface texture were recorded by one observer. All numeric data were subject to ANOVA with repeated measures followed by Tukey's test ( $\alpha=0.05$ ). Results: All materials were significantly different, independently to time and treatment. Initially, Luci Sof<sup>®</sup> and Sofreliner<sup>®</sup> immersed in either hypochlorite or peroxide increased the hardness mean values significantly. These hardness mean values decreased significantly after 720 cycles. Molloplast-B<sup>®</sup> showed no significant difference after the treatments, in any time. Conclusions: Denture cleansers had no effect on hardness of the resilient denture liners evaluated after 2 years of in vivo simulated conditions of hygiene. Sofreliner<sup>®</sup> was the smoothest material before and after all treatments.

**Uniterms:** Denture, complete; Resilient denture liner; Silicones; Hardness.

### RESUMO

**P**roposição: A maior desvantagem dos materiais reembasadores resilientes é a dificuldade em mantê-los limpos. Esse trabalho avaliou o efeito de agentes de limpeza sobre a dureza de reembasadores resilientes. Material e Métodos: Foram utilizados os materiais Luci Sof<sup>®</sup> (Dentsply), Molloplast-B<sup>®</sup> (Dentax) e Sofreliner<sup>®</sup> (Tokuyama), e os agentes de limpeza Hipoclorito de Sódio a 0,5% (Medicinalis-Farmácia de Manipulação) e Efferdent<sup>®</sup> (Warner-Lamber). Foram confeccionadas 20 amostras de cada material, com dimensões de 25X14X3mm. Foram realizados 2 tratamentos: 1) Hipoclorito de Sódio a 0,5% a 37 + 1°C, durante 20 minutos; 2) Peróxido Alcalino, a 37 + 1°C, durante 30 minutos. Após as imersões, as amostras foram lavadas e imersas em água destilada, a 37 ± 1°C, pelo período restante das 24 h. Esse processo foi repetido 8 vezes por dia, durante 90 dias. A dureza foi avaliada antes e após 360 e 720 ciclos, correspondente a 1 e 2 anos de uso clínico, respectivamente. O ensaio de dureza Shore A foi realizado em durômetro modelo GS-709 (Teclock-Japão), com aplicação de carga de 10 N por 1 segundo. Alterações macroscópicas, como perda de cor e alteração da superfície, foram avaliadas por um observador. Os resultados obtidos foram submetidos à ANOVA com medidas repetidas e ao Teste de Tukey (5%). Resultados: Os materiais apresentaram diferença significativa nos valores médios de dureza, independente do tratamento e do tempo. Luci Sof<sup>®</sup> e Sofreliner<sup>®</sup> aumentaram os valores médios de dureza inicialmente, os quais diminuíram após 720 ciclos significativamente, para ambos os tratamentos. Molloplast-B<sup>®</sup> não apresentou diferença significativa nos diferentes tempos e tratamentos. Conclusões: Os tratamentos em agentes de limpeza não alteraram os valores de dureza dos reembasadores resilientes após 2 anos de simulação clínica. Sofreliner<sup>®</sup> apresentou os menores valores de dureza, em todos os tempos e tratamentos, apresentando-se como o material mais macio.

**Unitermos:** Prótese total; Materiais resilientes; Silicones; Dureza.

## INTRODUCTION

Even though acrylic resin is commonly used for complete denture bases, patients often prefer resilient denture liners to conventional hard denture bases<sup>20</sup>. The use of resilient liners is designed to distribute functional and nonfunctional stresses more evenly and to have a dampening effect because of elastic behavior<sup>4</sup>. These properties make resilient liners useful for treating patients with atrophic ridge or resorption, bony undercuts, bruxism, congenital or acquired oral defects requiring obturation, xerostomia and dentures opposing natural teeth. Commercially available products include rubbery acrylic-, silicone-, fluorid- and olefin-type materials. However, there are some disadvantages to the use of these materials. It has been shown that resilient liners are easily colonized by *Candida albicans*<sup>12</sup>, which may cause an oral pathologic condition known as denture stomatitis when associated with poor oral and denture hygiene<sup>1</sup>. Prosthetic cleansing that removes *Candida albicans* is a necessary and important factor in preventing non-traumatic causes of denture stomatitis<sup>18</sup>. Consequently, the greatest disadvantage of the resilient lining material is the difficulty to maintain it clean<sup>10</sup>.

Routine methods commonly used for denture cleaning include the use of immersion cleansers and brushing<sup>2, 7</sup>. Brushing with or without an abrasive cleanser is also very effective in removing plaque; consequently, this cleansing method is very common<sup>2</sup>. It is still questionable whether brushing causes abrasion of resilient lining materials<sup>10, 17</sup>. While Wright<sup>20</sup> and Schmidt and Smith<sup>17</sup> observed no evidence that resilient liners are more difficult to clean than conventional dentures, neither were there any evidence of abrasion or wear of its surface, Makila and Honka<sup>10</sup> found wear of the material when submitted to brushing.

The immersion type denture cleansers may be defined as alkaline peroxides and hypochlorites, acids, disinfectants, and enzymes<sup>2</sup>. Ideally these solutions should be effective in removing stains and deposits from the denture; it should be simple to use and compatible with all denture base materials<sup>7</sup>. Although chemical denture cleansers have been considered to be an efficacious method to prevent *C. albicans* colonization and denture plaque formation<sup>6, 13</sup>, it is cited that a daily use of denture cleansers can affect the properties of both denture acrylic resin and resilient liners<sup>8</sup>.

<sup>11</sup>. Thus, dentists should choose denture cleansers by taking into account the compatibility of denture cleansers with resilient liners on both materials and biological aspects.

Resilient liners are made of materials from several chemical families. These materials undergo chemical changes over time as patients immerse their dentures in either the aqueous environment of the mouth or, when not in use, in tap water or denture cleansers. Since hardening of the material is one of the major reasons for failure of some resilient liners, and difficulty in cleaning these materials remains their disadvantage, the purpose of the present study was to investigate the effect of immersion denture cleansers on the hardness of three resilient liners. The hypothesis tested was that the immersion cleansers would not affect the hardness of the resilient liners evaluated.

## MATERIAL AND METHODS

The resilient liner materials and the denture cleansers used in this study are listed in Table 1. The resilient liners, Luci Sof<sup>®</sup>, Molloplast-B<sup>®</sup> and Sofreliner<sup>®</sup> were select because they are commonly used by clinicians. The test solutions consisted of one commercially available denture cleanser and one alkaline hypochlorite solution.

Thirty specimens (24 X 14 X 3 mm) of each material were prepared by investing dies in a standard metal dental flask (Uraby; DLC, São Paulo, Brazil). The thickness of the tested specimens chosen for this study was, as far as practical, representative of the clinical situation<sup>16, 17</sup>. The dies were invested in flexible silicone rubber (Zetalabor; Zhermack, Badia Polesine, Rovigo, Italy) to allow easy removal of the processed specimens from the flask. The flask was then completed with Type III dental stone (Herodent Soli-Rock; Vigodent, Rio de Janeiro, Brazil). After the complete setting of the gypsum, the two halves of the flask were separated and the dies removed. A separated medium (Cel Lac; S. S. White, Rio de Janeiro, Brazil) was applied to the exposed areas of the mold. Specimens were made by processing the resilient denture liners in the resulting mold according to the manufactures' instructions. Luci Sof<sup>®</sup> was processed by heating the flask in a water bath at 100 °C for 2 ½ hours. Molloplast-B<sup>®</sup> was processed in a water bath at 100 °C for 2 hours. Sofreliner<sup>®</sup> was processed at room temperature. After

**TABLE 1-** Resilient denture liners and denture cleansers

Brand	Material	Batch N.	Manufacturer
Luci Sof	Heat-curing silicone	990726A	Dentsply International Inc., York, PA - USA
Molloplast-B	Heat-curing silicone	011262	Dentax-Gmbh & Co. KG, Ettlingen - Germany.
Sofreliner	Chemical-curing Silicone	U46973	Tokuyama Dental Corp. Tokyo - Japan.
Efferdent	Alkaline Peroxide	BH 0783V	Pfizer Consumer Health Care, Morris Plains, NJ - EUA
Alkaline Hypochlorite	0.5% Alkaline Hypochlorite	011262	Medicinallis - Farmácia de Manipulação e Homeopatia, Piracicaba, SP – Brazil.

the polymerization, specimens were removed from the flask, and any flash was trimmed with a sharp knife. The specimens were then removed and stored in water at 37 °C for 24 hours, and randomly divided into 2 groups.

The immersion periods were chosen to resemble normal domestic usage. The alkaline peroxide solution was prepared by adding one tablet of Efferdent® to 200ml tap water (equivalent to the dilution recommended by the manufacturer) which was at initial temperature of 37 °C. The solution changed from blue to clear, and after 15 minutes, the specimens were washed thoroughly with tap water and distilled water. The specimens were immersed into 200 ml of 0.5% alkaline hypochlorite solution at initial temperature of 37 °C for 20 minutes. Fresh solutions were used for each immersion. Ten specimens of each material were immersed into the solution of each denture cleanser 8 times each day for a total of 720 treatments extending over a period of 90 days. Between the immersion periods, the specimens were stored in distilled water at 37 °C for the remainder of the 24 hours period.

**Shore A Hardness Test**

Hardness was measured using a Shore Durometer (GS-709, Teclock – Osaka, Japan), under a load of 10N for 1 second. The instrument consists of a blunt-pointed indenter attached to a scale by lever arrangement with a recording scale from 0 to 100 Shore A units. The more the indenter penetrates the specimen, the lower the hardness value is. The shaft was lowered onto the middle of the specimen, and the highest reading was noted. Five readings were obtained for each specimen, and the final hardness mean value calculated for each specimen. One representative specimen was selected of each group. The data from the each assay were subjected to Analysis of Variance with repeated measures and Tukey test (5%).

**Visual Assessment**

All specimens were examined visually on days 360 and 720 and were compared with the controls so that one observer could note any macroscopic changes such as loss

of color or alteration in surface texture. Any changes were recorded on a grading system of slight, moderate or marked<sup>3</sup>.

All numeric data were submitted to Analysis of Variance followed by Tukey’s test ( $\alpha=0.05$ ).

**RESULTS**

Table 2 lists the hardness mean values of the resilient liners subjected to the cleansing treatments. Before the immersion treatments, Sofreliner® presented the lowest hardness mean values, followed by Molloplast-B® and Luci Sof®. The denture cleansers treatment significantly increased the hardness mean values of Luci Sof® and Sofreliner® after 360 immersion cycles. However, these values decreased significantly after 720 immersion cycles. The denture cleansers treatment did not significantly affect Molloplast-B® mean values, either after 360 or 720 immersion cycles.

The changes observed after 360 and 720 are summarized in Table 3. Marked color loss was observed after 720 immersion cycles for all materials. The peroxide treatment promoted loss of surface sheen of all materials.

**DISCUSSION**

Resilient liners undergo through changes over time as patients immerse their dentures in either aqueous environment of the mouth or, when not in use, in tap water or denture cleansers. Hardening of the material is one of the major reasons for failure of resilient liners<sup>9</sup>. Therefore, it is important to evaluate if denture cleansers can affect the hardness of the resilient liners.

Initial measurements showed that Luci Sof® presented the highest hardness mean values, followed by Molloplast-B® and Sofreliner®. Hardness mean values for the heat-cured materials (Luci Sof® and Molloplast-B®) were significantly greater than those for the self-curing one, in agreement with other studies<sup>9,14,15</sup>. This difference might be explained

**TABLE 2-** Mean hardness and ± standard deviation of denture materials before and after 360 and 720 cycles (n=10)

Denture Cleanser	Material	Control	Time	
			360	720
Peroxide	LS	42.75 ± 2.02 Ab	43.51 ± 1.11 Aa	42.77 ± 2.05Ab
	MO	37.71 ± 3.16 Ba	37.74 ± 2.60 Ba	37.81 ± 3.37 Ba
	SO	28.76 ± 1.92 Cb	31.50 ± 1.33 Ca	28.76 ± 1.92Cb
Hypochlorite	LS	43.62 ± 1.59 Ab	44.46 ± 1.31Aa	43.62 ± 1.59 Ab
	MO	37.34 ± 2.38 Ba	37.53 2.73± Ba	36.84 ± 2.98Ba
	SO	29.25 ± 1.99 Cb	30.67 ± 1.44 Ca	29.25 ± 1.99Cb

Means followed by the same upper case letter in a column (time and treatment) and the same lower case letter in a row (material and treatment) do not differ statistically by Tukey at a 5% probability level. (p = 0.7440)

because of the polymerization mode of the materials as well as their composition. Increased processing temperatures were expected to result in a more complete polymerization reaction and thus a harder polymer<sup>15</sup>. Although Luci Sof<sup>®</sup> and Molloplast-B<sup>®</sup> are heat-cured materials, they have different polymerization periods. Luci Sof<sup>®</sup> was processed for 2½ hours in boiling water, and Molloplast-B<sup>®</sup> was processed for 2 hours in boiling water, following the manufacturer’s directions. This different period of processing resulted in a more complete polymerization reaction<sup>14</sup>, and this might lead to higher hardness mean values. Sofreliner<sup>®</sup> is a chemically cured material, and this processing type might result in incomplete initial polymerization and thus lower hardness values.

Luci Sof<sup>®</sup> and Sofreliner<sup>®</sup> hardened significantly after 360 immersion cycles. This was likely due to continued polymerization of those, as cited by Dootz, et al.<sup>4</sup> (1993). The materials softened during the remainder of the test period, approaching the initial hardness mean values by the end of the study period, in agreement with Kiat-Amnuay, et al.<sup>9</sup> (2005), who tested resilient liners’ hardness after water storage. Silicone-based materials do not contain plasticizer, but does contain filler<sup>16</sup>, and the absorption of water by the filler could lead to increased softness of the materials evaluated. The decrease of hardness mean values after immersion in denture cleansers occurred because of the absorption of water by the fillers. However, denture cleansers had no effect on Molloplast-B<sup>®</sup> mean hardness values, after either 360 or 720 cycles. Tan, et al.<sup>19</sup> (2000) did not find significant differences in Molloplast-B<sup>®</sup> mean values after immersion treatment in either hypochlorite or peroxide. The authors suggest that this was resulted because of an arbitrary test period and a small experimental group. However, the present study evaluated a longer test period and twenty specimens, and the material presented a linear behavior during it.

Although hypochlorite caused a marked loss of color in all materials tested, it is questionable whether this change would be of importance clinically. However, it is advisable to warn patients who are provided with a denture relined

with these materials that although fading of the lining might occur, this does not indicate that the resilient liner is unsatisfactory. The resilient liners also showed some mirror surface change in the form of loss of sheen. Davenport, et al.<sup>3</sup> (1986) suggests that this is the result of an increase in surface roughness. Plaque retention is increased in this situation. However, this is less likely to be of significance when the denture cleanser being used is effective in removing plaque from prostheses.

Within the limitations of this study, Sofreliner<sup>®</sup> displayed the lowest hardness values before and after the immersion in denture cleansers. According to Gonzalez<sup>5</sup> resilient liners should have a Shore A Durometer hardness of approximately 20 to 25 units and not change hardness with service. Only Sofreliner<sup>®</sup> presented values close to those suggested. However, it should be elucidated if this difference is clinically relevant. In addition, selection of a resilient liner cannot be based on any single property. Lower hardness values is a desirable property for these materials, but other factors, such as bond strength to denture base, lower surface roughness values, tear strength, water sorption and solubility, must also be considered when selecting these materials.

**CONCLUSIONS**

Under the conditions of this study, the following conclusions were drawn:

1. Denture cleansers significantly increased Luci Sof<sup>®</sup> and Sofreliner<sup>®</sup> hardness mean values after 360 immersion cycles, and decreased significantly after 720 cycles.
2. Denture cleansers had no effect on Molloplast-B<sup>®</sup> hardness mean values either after 360 or 720 immersion cycles.
3. Sofreliner<sup>®</sup> was the smoothest material under the conditions of the present study, before and after the treatments.

**TABLE 3-** Observed changes in resilient denture liners after 360 and 720 immersions in denture cleansers

Treatment	Material	360	720
Hypochlorite	Luci Sof	Slight colour loss	Slight colour loss
	Molloplast-B	Slight colour loss; Slight loss of surface sheen.	Marked colour loss; Marked loss of surface sheen.
	Sofreliner	Slight loss of surface sheen.	Marked colour loss; Slight loss of surface sheen.
Peroxide	Luci Sof	Moderate colour loss	Marked colour loss
	Molloplast-B	Slight colour loss; Moderate loss of surface sheen.	Marked colour loss; Marked loss of surface sheen.
	Sofreliner	Slight loss of surface sheen.	Moderate colour loss; Moderate loss of surface sheen.

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