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Original Research

Absorption of Different Soft Lining Materials in Distilled Water, Artificial Saliva and Denture Disinfectant Solution

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Abstract:

Background: The aim of this study was to compare water absorption of different soft lining materials in distilled water, artificial saliva and sodium hypochlorite denture disinfectant solution (5.25%) under controlled laboratory environment.

Materials and Methods: Four different materials were used; heat cured and self-cured silicones; heat cured and self-cured acrylic liners. A total of 30 specimens of each material were made of which 10 of the specimens were immersed in distilled water, 10 in artificial saliva for the whole 24 h period and the other 10 specimens were immersed in sodium hypochlorite denture disinfectant solution (5.25%) for 8 h daily. Absorption tests were conducted, and statistical analysis was done.

Results: The heat cured silicone exhibited lowest absorption, while high values were shown by self-cured acrylic liner. When absorption values were compared with three different solutions, the self-cured acrylic soft liner showed higher absorption values in sodium hypochlorite denture disinfectant solution (5.25%) and heat cured silicone soft liner showed lowest values in all the solutions and at various intervals of time.

Conclusion: With the exception of Molloplast-B all the soft liners studied showed higher absorption in different solutions, i.e., sodium hypochlorite denture disinfectant solution (5.25%), artificial saliva and distilled water. So overall, Molloplast-B (heat cured silicone) soft lining material performed better than all the other materials compared.

Key Words: Absorption, denture cleanser, heat cured liners, self-cured liners, soft denture liners

Introduction

Denture soft liner materials have been used in dentistry for many years. Denture soft liners have a key role in modern removable prosthodontics because of their capability of restoring health of the inflamed and distorted mucosa.[1]

Patients with chronic soreness from dentures present an extremely difficult problem for prosthodontic treatment. This condition is caused mainly by irritation from faulty dentures, by bruxism, or by denture irritation secondary to a systemic condition. Abused soft tissues supporting dentures often distort and destroy underlying bone resulting in continued escalation of the deformation.

Soft lining materials are used for patient comfort, for the treatment of the atrophic ridge, bone undercuts, bruxism, xerostomia, and denture opposing natural teeth. They are also used to secure dynamic impressions, as tissue conditioners to restore the traumatized oral mucosa to a healthy state, as temporary reliners to maintain the fit of a denture and prevent trauma, and for trial evaluation of border extension. It is necessary to apply the soft lining material to the fitting surface of a denture in order to act as a "cushion" which will enable traumatized soft tissues to recover before recording an impression for a new denture.[2]

During clinical use, soft liners are in saliva and during storage of the denture; they may be soaked in an aqueous cleaning solution or in water which may result in absorption of these solutions in soft lining materials.

This process is important as it is going to have an impact on the physical properties of the material and its dimensional stability. To predict clinical behavior, the amount of water absorbed must be measured over a period which is comparable with the proposed period of use in the oral environment.[3]

Previous authors[3-5] have studied the absorption of soft lining materials in distilled water and artificial saliva. An ideal soft liner should have low absorption even in denture disinfectant

solution. Hence, the purpose of this study was to evaluate absorption of different commercially available soft lining materials in sodium hypochlorite denture disinfectant solution (5.25%), artificial saliva and distilled water under controlled laboratory environment.

Materials and Methods

Method followed

A standard aluminum disk (30 mm in diameter and 1 mm in thickness) was used to make test samples.

Preparation of dental stone mold space

Aluminum disks were invested in dental flasks using dental stone. Once the stone was set completely, each flask was opened, and the aluminum disk was removed to create the mold space. The mold space thus obtained was used for the preparation of the soft liner specimen.

Four different liner materials were (30 specimens of each) used for sample preparation.

Total sample size = 120.

Preparation of soft liner specimens

Group A: Heat cured silicone soft liner (Molloplast-B) material was used in single component form. The material was kneaded and packed into the mold space. Curing was done followed by bench cooling for overnight, before removing the cured specimens.

Group B: The self-cured silicone soft liner (Mucopren) material supplied as catalyst and base paste in a cartridge. The material was injected into the mold space and spread. The flask was closed and held under bench press for 5 min. After 5 min the flask was opened, the specimen was removed and trimmed.

Group C: The heat cured acrylic soft liner (Super Soft) material was used in the powder-liquid form. The powder and liquid were mixed according to the ratio recommended by the manufacturer (4 ml liquid: 5 g powder). When the mix reached the dough stage, it was kneaded and packed into the mold space, curing was done followed by bench cooling for overnight, before removing the cured specimens.

Group D: The self-cured acrylic liner (Soft Liner) was used in a powder-liquid form. The powder and liquid were mixed and packed into the mold. The flask was closed and held under bench press for 4-5 min. After 5 min the flask was opened, the specimen was removed and trimmed using a Bard Parker blade.

Water solubility test

The procedure for absorption testing was done as done by the authors Kazanji and Watkinson.[3]

All the samples were dried in desiccators containing silica crystals until they all reached a stable weight (for about 24 h). The conditioned weight of all specimens was measured on the electronic weighing machine and recorded as (W1).

Then, 10 of the specimens were immersed in distilled water and 10 in artificial saliva for the whole 24 h period. The other 10 specimens were immersed in denture disinfectant solution (5.25% sodium hypochlorite) for 8 h daily, washed thoroughly with tap water and distilled water, and immersed into distilled water for the remainder of the 24-h period.

The container and specimens were stored at 37°C ± 2°C. The specimens were subsequently removed from their container at 24 h, 1 week, 2 weeks and 1 month. Excess water or denture disinfectant solution was removed by blotting with filter paper. The amount of soluble material lost was measured by drying the specimens in the desiccators after each desorption cycle and was recorded as (W2). The amount of soluble material lost was measured by drying the specimens in the desiccators after each absorption or desorption cycle and was recorded as (W3). This procedure was repeated after intervals of immersion of 24 h, 1 week, 2 weeks and 1 month.

Then the percentage absorption was calculated according to the formula:

$$\text{Absortion } \% = \frac{W2 - W3}{W1} \times 100$$

Where in,

W1 = Initial weight,
W2 = Weight after absorption or desorption,
W3 = Final weight after desiccation.

Statistical test

Descriptive (mean ± standard deviation) and comparative statistics were used. One-way ANOVA was performed for multiple comparisons followed by *post-hoc* Tukey's test for pairwise comparisons. A level of significance was set at 95% with a $P < 0.05$.

Results

The results obtained from the study are shown in Tables 1-3.

Table 1 depicts mean percentage absorption of different materials in sodium hypochlorite denture disinfectant solution (5.25%). Molloplast-B showed least absorption in sodium hypochlorite denture disinfectant solution when compared to other materials followed by Super Soft, Mucopren and Soft Liner after the duration of 1 month.

Table 2 depicts mean percentage absorption of different materials in artificial saliva. Molloplast-B showed least absorption in artificial saliva when compared to other materials followed by Super Soft, Mucopren and Soft Liner after the duration of 1 month.

Table 1: Mean percentage absorption of different materials in sodium hypochlorite denture disinfectant solution (5.25%).

Time interval	Materials	Mean	SD	*F* value	*P* value	Significant difference between
After 24 h	Molloplast-B	0.01189	0.021748	38.899	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&3, 2&4
	Mucopren	0.05232	0.0152264			
	Super soft	0.09785	0.0337365			
	Soft liner	0.1233	0.0256660			
After 1 week	Molloplast-B	0.06033	0.0388572	8.713	0.000 *P*<0.0001 HS	1&3, 1&4, 2&4
	Mucopren	0.10234	0.0526292			
	Super soft	0.12237	0.0367919			
	Soft liner	0.1698	0.0620812			
After 2 weeks	Molloplast-B	0.1424	0.0410954	46.173	0.000 *P*<0.0001 HS	1&4, 2&4, 3&4
	Mucopren	0.23384	0.0402823			
	Super soft	0.31136	0.0487590			
	Soft liner	1.67148	0.6770871			
After 1 month	Molloplast-B	0.31177	0.0973883	246.694	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&4, 3&4
	Mucopren	1.43598	0.1369447			
	Super soft	1.22503	0.2438957			
	Soft liner	2.54509	0.2208749			

1: Molloplast-B, 2: Mucopren, 3: Super Soft, 4: Soft Liner. SD: Standard deviation, HS: Highly significant

Table 2: Mean percentage absorption of different materials in artificial saliva.

Time interval	Materials	Mean	SD	*F* value	*P* value	Significant difference between
After 24 h	Molloplast-B	0.01363	0.0177414	23.008	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&3, 2&4
	Mucopren	0.06773	0.0257947			
	Super Soft	0.12124	0.0513576			
	Soft Liner	0.13338	0.0402759			
After 1 week	Molloplast-B	0.03524	0.0212666	18.412	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&4, 3&4
	Mucopren	0.1039	0.0329998			
	Super Soft	0.12057	0.0489360			
	Soft Liner	0.18708	0.0671825			
After 2 weeks	Molloplast-B	0.11883	0.0133512	42.571	0.000 *P*<0.0001 HS	1&4, 2&4, 3&4
	Mucopren	0.19294	0.0620177			
	Super Soft	0.30563	0.0585291			
	Soft Liner	1.7069	0.7262216			
After 1 month	Molloplast-B	0.24828	0.0456362	904.989	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&3, 2&4, 3&4
	Mucopren	1.49291	0.0691573			
	Super Soft	1.22342	0.1015323			
	Soft Liner	2.65175	0.1613669			

1: Molloplast-B, 2: Mucopren, 3: Super Soft, 4: Soft liner, SD: Standard deviation, HS: Highly significant

Table 3 depicts mean percentage absorption of different materials in distilled water. Molloplast-B showed least absorption in distilled water when compared to other materials followed by Super Soft, Mucopren, and Soft Liner after the duration of 1 week and 1 month, respectively.

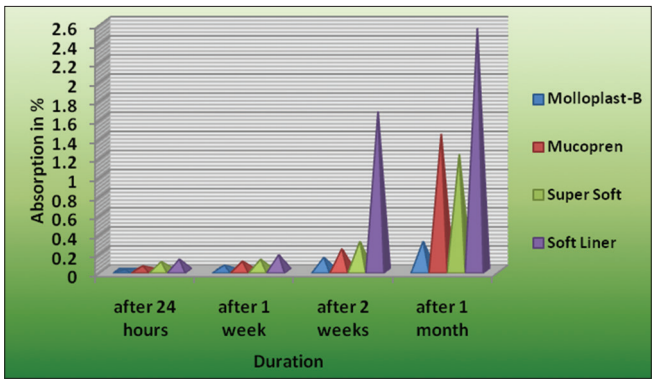
Discussion

Soft denture lining materials have been used in dentistry for more than a century with the earliest being natural rubbers. Today soft lining materials included silicone elastomers and plasticized acrylic resins.[6]

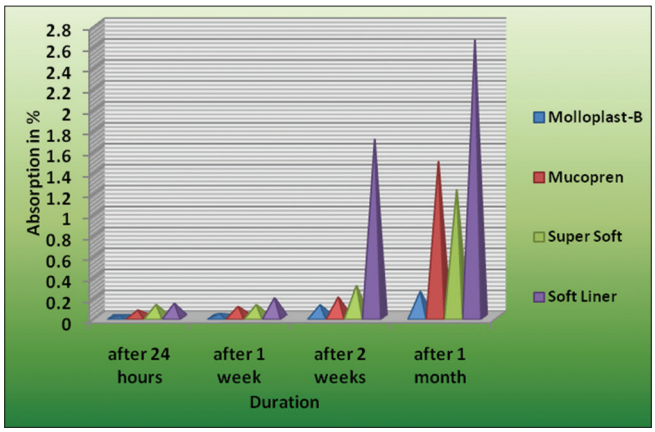
Table 3: Mean percentage absorption of different materials in distilled water.

Time interval	Materials	Mean	SD	*F* value	*P* value	Significant difference between
After 24 h	Molloplast-B	0.01473	0.0164371	31.498	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&3, 2&4
	Mucopren	0.07223	0.0306432			
	Super Soft	0.13521	0.0402710			
	Soft Liner	0.13616	0.0383121			
After 1 week	Molloplast-B	0.03089	0.0104041	18.852	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4
	Mucopren	0.19356	0.0452435			
	Super Soft	0.18014	0.0749559			
	Soft Liner	0.1698	0.0620812			
After 2 weeks	Molloplast-B	0.14943	0.0373607	44.896	0.000 *P*<0.0001 HS	1&4, 2&4, 3&4
	Mucopren	0.21966	0.0528543			
	Super Soft	0.26305	0.0340278			
	Soft Liner	1.6714	0.6770871			
After 1 month	Molloplast-B	0.34534	0.0338037	363.358	0.000 *P*<0.0001 HS	1&2, 1&3, 1&4, 2&3, 2&4, 3&4
	Mucopren	1.42946	0.0861000			
	Super Soft	1.18756	0.1424312			
	Soft Liner	2.4995	0.2405127			

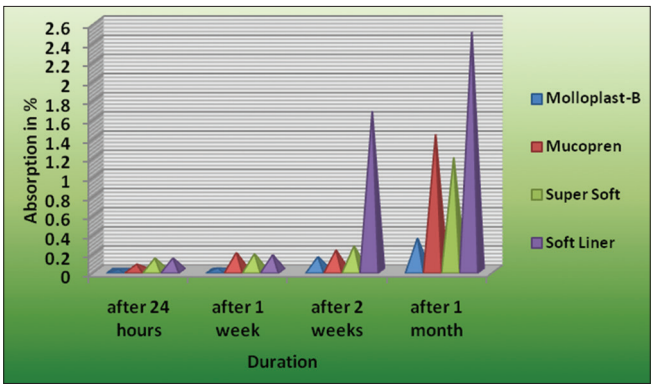
1: Molloplast-B, 2: Mucopren, 3: Super Soft, 4: Soft Liner, SD: Standard deviation, HS: Highly significant



Graph 1: Mean percentage absorption of different materials in sodium hypochlorite denture disinfectant solution.



Graph 2: Mean percentage absorption of different materials in artificial saliva.



Graph 3: Mean percentage absorption of different materials in distilled water.

Soft denture liners are polymeric materials placed on the tissue contacting surface of a denture base to absorb some of the energy produced by masticatory impact and to act as a type of shock absorber between the occlusal surfaces of a denture and the underlying oral tissues.[7]

Certain clinical limitations occur with the use of soft liners primarily resulting from failures in their physical properties. Desirable properties for a soft liner include: Resilience, tear resistance, viscoelasticity, biocompatibility, lack of odor and taste, bond strength, low solubility in saliva, low sorption of saliva, ease of adjustability, dimensional stability, color stability, lack of adverse effect on denture base material, resistance to abrasion, and ease of cleaning.[8]

Acrylics and silicones are two main families of polymers used commercially as soft liners though other rubbers have been used in limited clinical experiments.[9]

During clinical use, soft lining materials are exposed to saliva and during storage; they may be soaked in an aqueous cleaning solution or in water.[3] As they are constantly bathed either in saliva or in some aqueous solution, their rheological properties deteriorate.[10]

In these situations, there are two processes taking place simultaneously; water or saliva may be absorbed into the material and plasticizers or other constituents may be leached out. Both processes are important in the effects they are likely to have on the physical properties of the material and its dimensional stability. To predict the clinical behavior, both the amount of water absorbed and the amount of soluble material lost must be measured over a period of use in the oral environment.[4] Hence the necessity arises, to study the absorption of soft lining materials in different solutions.

Aloul and Shen[11] examined the changes in the mechanical properties of temporary soft liners introduced by differential loss of plasticizer in different storage media and found that the plasticizer leaching occurred at a higher level in artificial saliva than in other storage media.

Several investigators[3,6,12] have studied absorption in different solutions. However, most of their studies included distilled water and artificial saliva but not denture disinfectant solution. The mean percentage absorption of Molloplast-B in all the three different solutions for different time intervals were non-significant as shown in Tables 1-3 and Graph 1.

The values were in correlation when compared with the study done by Kazanji and Watkinson[3] in artificial saliva and distilled water after 1 week and was found to be higher in artificial saliva and distilled water after 1 month. The mean percentage absorption of Mucopren in all the three different solutions was found to be significant ($P = 0.019$) after 1 week as shown in Tables 1-3 and Graph 2.

The values were lower when compared with the study done by Kazanji and Watkinson[3] in artificial saliva and distilled water after 1 week and 1 month. Furthermore, it was low when compared with the study done by El-Hadary and Drummond[6] in distilled water after 1 week and higher after 1 month.

The mean percentage absorption of Super Soft in all the three different solutions was found to be significant ($P = 0.039$) after 1 month as shown in Tables 1-3 and Graph 3.

The mean percentage absorption of different materials in sodium hypochlorite denture disinfectant solution (5.25%) and artificial saliva was found to be highly significant ($P = 0.000$) for different time intervals as shown in Tables 1 and 2 and Graph 1.

The mean percentage absorption of different materials in distilled water was found to be highly significant ($P = 0.000$) for different time intervals.

The mean percentage absorption of different materials was commonly found to be more in sodium hypochlorite denture disinfectant solution (5.25%) followed by artificial saliva and distilled water.

The probable reason may be attributed to the higher release of soluble components. These findings are in agreement with Goll *et al.*,[7] who reported a decrease in the resilient lining weight after 30 days of water storage and daily overnight immersion in denture cleanser. The higher ionic concentration of denture cleanser compared to water might have led to a higher release of soluble components.[13]

The results of this study were in confirmation with the results shown by Nikawa *et al.*[2] who found silicone liners to be more stable than the heat cured and auto polymerizing acrylic liners (in terms of solubility) after 8 h immersion in sodium hypochlorite denture cleanser solution for 1 month. The weight loss was explained to be related to the greater solubility of plasticizers in ionic solutions than in water.[14,15]

From the values of absorption it can be inferred that the Molloplast-B which is heat cured silicone was the most stable followed by Mucopren which is self-cured silicone followed by Super Soft which is heat cured acrylic and lastly the Soft Liner which is self-cured acrylic.

The variation in the results may be due to; these materials can leach soluble components depending on their composition and the solution in which they are immersed. The weight changes of the materials may be explained by molecular weight which is considered to be an important property capable of influencing the performance of a polymer.[6] Furthermore, the rate at which the materials lost soluble components varied considerably with the type of material, amount of plasticizer or the filler content.[3]

Conclusion

It was concluded from the present study that the silicone liners exhibited superior properties compared to the acrylics in terms of absorption, with the heat cured silicone showing lowest absorption. The self cured acrylic liner followed by the heat cured acrylic liner exhibited high absorption values.

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