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SOLUBILITY OF DIFFERENT SOFT LINING MATERIALS IN DISTILLED WATER, ARTIFICIAL SALIVA AND DENTURE DISINFECTANT SOLUTION

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ABSTRACT

Aim: The aim of this study was to compare water solubility of different soft lining materials in distilled water, artificial saliva and sodium hypochlorite denture disinfectant solution (5.25%) under controlled laboratory environment. **Methodology:** 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 ten of the specimens were immersed in distilled water, ten in artificial saliva for the whole 24 hours period and the other ten specimens were immersed in sodium hypochlorite denture disinfectant solution (5.25%) for 8 hours daily. solubility tests were conducted and statistical analysis was done. **Results:** The heat cured silicone exhibited lowest solubility, while high values were shown by self cured acrylic liner. When solubility values were compared in three different solutions, the self cured acrylic soft liner showed higher solubility 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 solubility 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.

KEYWORDS: Solubility; soft denture liners; heat cured liners; self cured liners; denture cleanser

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 inflamed and distorted mucosa.[1] The patient with chronic soreness from dentures presents 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. The 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 cleansing solution or in water which may cause the soluble materials of denture

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

	MATERIALS	MEAN	SD	F value	p value	Sig dif between
AFTER 24 HOURS	Molloplast-B	0.00616	0.0107987	30.594	0.000 p<0.0001 H S	1&2, 1&3, 1&4, 2&3, 2&4
	Mucopren	0.02611	0.0127404			
	Super Soft	0.04557	0.0146717			
	Soft Liner	0.05697	0.0126038			
AFTER 1 WEEK	Molloplast-B	0.02736	0.0164287	8.896	0.000 p<0.0001 H S	1&3, 1&4, 2&4
	Mucopren	0.04576	0.0243459			
	Super Soft	0.05806	0.0210392			
	Soft Liner	0.0825	0.0331715			
AFTER 2 WEEKS	Molloplast-B	0.06196	0.0362522	18.081	0.000 p<0.0001 H S	1&4, 2&4, 3&4
	Mucopren	0.07765	0.0204248			
	Super Soft	0.12177	0.0318915			
	Soft Liner	1.22353	0.8443286			
AFTER 1 MONTH	Molloplast-B	0.11036	0.0273792	209.191	0.000 p<0.0001 H S	1&2, 1&3, 1&4, 2&3, 2&4, 3&4
	Mucopren	0.99969	0.0868907			
	Super Soft	0.60231	0.1394855			
	Soft Liner	1.51853	0.2012019			

1= Molloplast–B, 2= Mucopren, 3= Super Soft, 4= Soft liner
SD = STANDARD DEVIATION, H S = HIGHLY SIGNIFICANT

Table 2: Mean percentage solubility of different materials in artificial saliva

	MATERIALS	MEAN	SD	F value	p value	Sig dif between
AFTER 24 HOURS	Molloplast-B	0.00645	0.0089044	13.216	0.000 p<0.0001 H S	1&3, 1&4, 2&4
	Mucopren	0.02917	0.0141700			
	Super Soft	0.05195	0.0296738			
	Soft Liner	0.05994	0.02447829			
AFTER 1 WEEK	Molloplast-B	0.01445	0.0095059	12.898	0.000 p<0.0001 H S	1&2, 1&3, 1&4, 2&4, 3&4
	Mucopren	0.04848	0.0217610			
	Super Soft	0.05183	0.0299214			
	Soft Liner	0.08927	0.0379881			
AFTER 2 WEEKS	Molloplast-B	0.05539	0.0175081	28.928	0.000 p<0.0001 H S	1&4, 2&4, 3&4
	Mucopren	0.08442	0.0219717			
	Super Soft	0.12073	0.0456256			
	Soft Liner	1.04055	0.5590509			
AFTER 1 MONTH	Molloplast-B	0.10212	0.0243482	832.963	0.000 p<0.0001 H S	1&2, 1&3,1&4, 2&3, 2&4, 3&4
	Mucopren	0.9695	0.06903321			
	Super Soft	0.71254	0.1016145			
	Soft Liner	1.63214	0.0973223			

soft liners to leach out. 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 soluble material lost must be measured over a period which is comparable with the proposed period of use in the oral environment.[3] Previous authors [3-9] have studied the solubility of soft lining materials in distilled water and artificial saliva. An ideal soft liner should have no soluble components even in denture disinfectant solution. Hence the purpose of this study was to evaluate solubility 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 aluminium disk (30 mm in diameter and 1 mm in thickness) was used to make test samples.

Preparation of dental stone mold space

Aluminium disks were invested in dental flasks using dental stone. once the stone was set completely, each flask was opened and the

Table 3: Mean percentage solubility of different materials in distilled water

	MATERIALS	MEAN	SD	F value	p value	Sig dif between
AFTER 24 HOURS	Molloplast-B	0.00899	0.0116913	16.669	0.000 p<0.0001 H S	1&2, 1&3,1&4, 2&3, 2&4
	Mucopren	0.035859	0.0161486			
	Super Soft	0.06101	0.0240832			
	Soft Liner	0.06269	0.0235739			
AFTER 1 WEEK	Molloplast-B	0.02035	0.0105575	8.908	0.000 p<0.0001 H S	1&2, 1&3,1&4
	Mucopren	0.07795	0.0318226			
	Super Soft	0.08597	0.0437950			
	Soft Liner	0.0825	0.033171			
AFTER 2 WEEKS	Molloplast-B	0.0654	0.0267528	40.954	0.000 p<0.0001 H S	1&4, 2&4, 3&4
	Mucopren	0.14744	0.1757289			
	Super Soft	0.09774	0.0225792			
	Soft Liner	1.2235	0.8443286			
AFTER 1 MONTH	Molloplast-B	0.0881	0.0248441	314.33	0.000 p<0.0001 H S	1&2, 1&3,1&4, 2&3, 2&4, 3&4
	Mucopren	0.93762	0.0659116			
	Super Soft	0.59612	0.0736306			
	Soft Liner	1.50821	0.1868283			

1= Molloplast–B, 2= Mucopren, 3= Super Soft, 4= Soft liner SD = STANDARD DEVIATION, H S = HIGHLY SIGNIFICANT

aluminium disk was removed to create the mold space. The mold space thus obtained was used for the preparation of the soft liner specimen.

4 different liner materials were used for sample preparation.

Total sample size = 120.

30 specimens of heat cured silicone soft liner (Molloplast-B)

30 specimens of self cured silicone soft liner (Mucopren)

30 specimens of heat cured acrylic soft liner (Super Soft)

30 specimens of self cured acrylic soft liner (Soft Liner).

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 mould 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 powder-liquid form. The powder and liquid were mixed according to the ratio recommended by the manufacturer (4 ml liquid: 5 gms powder). When the mix reached the dough stage, it was kneaded and packed into the mould 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 mould. 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 solubility testing was done as done by the authors Kazanji MNM, Watkinson AC.[3] All the samples were dried in desiccators containing silica crystals until they all reached a stable weight (for about 24 hours). The conditioned weight of all specimens was measured on the electronic weighing machine and recorded as (W1). Then ten of the specimens were immersed in distilled water and ten in artificial saliva for the whole 24 hours period. The other ten specimens were immersed in denture disinfectant solution (5.25% sodium hypochlorite) for 8 hours daily, washed thoroughly with tap water and distilled water, and immersed into distilled water for the remainder of the 24- hour period. The container and specimens were stored at 37^0+/-2^0c. The specimens were subsequently removed from their container at 24 hours, 1 week, 2 weeks and 1 month. Excess water or denture

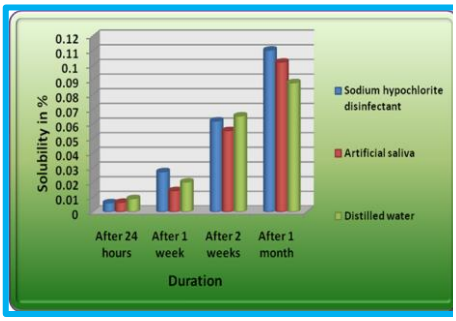

Fig. 1: Mean percentage solubility of Molloplast-B in different solutions

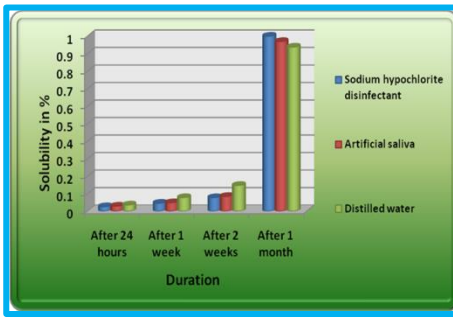

Fig. 2: Mean percentage solubility of Mucopren in different solutions

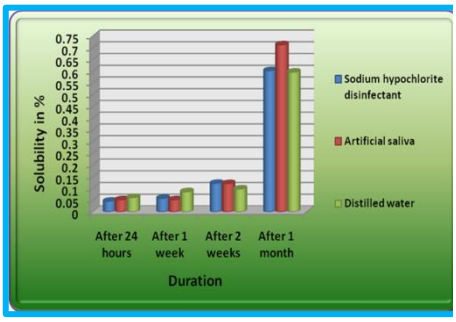

Fig. 3: Mean percentage solubility of Super Soft in different solutions

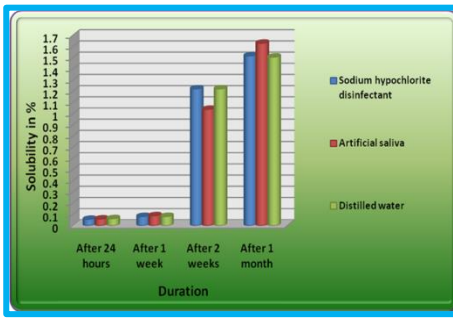

Fig. 4: Mean percentage solubility of Soft Liner in different solutions

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). This procedure was repeated after intervals of immersion of 24 hours, 1 week, 2 weeks and 1 month.

STATISTICAL TEST

Descriptive (mean +/- SD) and comparative statistics were used. One way ANOVA was performed for multiple comparisons followed by Post-Hoc Tukey's test for pair wise comparisons. A level of significance was set at 95% with a p value < 0.05.

RESULTS

The results obtained from the study are shown in the tables. Table1 depicts Mean percentage solubility of different materials in sodium hypochlorite denture disinfectant solution (5.25%). The mean percentage solubility of different materials in sodium hypochlorite denture disinfectant solution (5.25%) at different time intervals were shown in table 1. Molloplast-B showed least solubility 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 solubility of different materials in artificial saliva. Molloplast-B showed least solubility in artificial saliva when compared to other materials followed by Super Soft, Mucopren and Soft Liner after the duration of 1 month. Table 3 depicts Mean percentage solubility of different materials in distilled water. Molloplast-B showed least solubility in distilled water when compared to other materials followed by Super Soft, Mucopren and Soft Liner after the duration of 2 weeks and 1 month respectively.

DISCUSSION

Soft denture lining materials have been used in dentistry for more than a century with the earliest soft liners being natural rubbers. One of the first synthetic resins developed in 1945 as a soft liner was a plasticized poly vinyl resin followed by the introduction of silicones in 1958. Today soft lining materials include silicone elastomers and plasticized acrylic resins.[11] 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.[14] 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.[13] Acrylics and silicones are two main families of polymers used commercially as soft liners, though other rubbers have been used in limited clinical experiments.[15] During clinical use, soft lining materials are exposed to saliva and during storage, they may be soaked in an aqueous cleansing solution or in water.[3] As they are constantly bathed either in saliva or in some aqueous solution, their rheological properties deteriorate.[6] 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 solubility of soft lining materials in different solutions. Aloul RK, Shen C,[12] 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. According to the revised ADA No.12 for denture base polymers,[4] the specifications for solubility is given as follows:

Solubility: the loss of weight of the polymer shall not be more than 0.04 mg/cm^2 of surface when tested according to the specification. The rate at which these materials loose soluble components varied considerably with the type of material, the amount of plasticizers or filler content and the solution in which they are immersed. The contact angle, wetting ability of saliva also affects the desorption processes of these resins. This wettability of saliva is required as an adequate lubricating layer formed over the surface of the liners.[5] Several investigators,[3,6,8] have studied solubility in different solutions. However, most of their studies included distilled water and artificial saliva but not denture disinfectant solution. The mean percentage solubility of Molloplast-B in all the 3 different solutions for different time intervals were non significant. The values were in correlation when compared with the study done by Kazanji MNM, Watkinson AC[3] in artificial saliva & distilled water after 1 week and was found to be higher in artificial saliva and distilled water after 1 month. The mean percentage solubility of Mucopren in all the 3 different solutions was found to be significant (p-0.019) after 1 week. The values were lower when compared with the study done by Kazanji MNM, Watkinson AC[3] in artificial saliva and distilled water after 1 week & 1 month. Also it was low when compared with the study done by Hadary AE, Drummond JL[10] in distilled water after 1 week and higher after 1 month. The mean percentage solubility of Super Soft in all the 3 different solutions was found to be significant (p-0.039) after 1 month. The values were lower when compared with the study done by Kazanji MNM, Watkinson AC[3] in artificial saliva and distilled water after 1 week & 1 month respectively. The mean percentage solubility of Soft Liner in all the 3 different solutions for different time intervals were non significant. The values were lower when compared with the study done by Kazanji MNM, Watkinson AC[3] in artificial saliva and distilled water after 1 week & 1 month respectively. Also it was low when compared with the study done by Hadary AE, Drummond JL[10] in distilled water after 1 week and higher after 1 month. The mean percentage solubility 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. The mean percentage solubility of different materials in distilled water was found to be highly significant (p-0.000) for different time intervals. The mean percentage solubility of different materials was commonly found to be more in sodium hypochlorite denture disinfectant solution (5.25%) followed by artificial saliva & distilled water. The probable reason may be attributed to the higher release of soluble components. These findings are in agreement with Goll G, Smith DE, Plein JB[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. From the values of solubility 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. Hence, silicones performed better than the acrylics. The reasons for the better behavior of silicones over acrylics could be because of their better polymerization, cross-linking, low plasticizer content and more filler content. 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.[11] Also 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

The present study was planned to compare solubility of different soft lining materials in distilled water, artificial saliva and sodium hypochlorite denture disinfectant solution (5.25%) under controlled laboratory environment. After the statistical analysis and correlation the following conclusions were made; The solubility values of different soft liners studied showed high values in sodium hypochlorite denture disinfectant solution (5.25%). Therefore, the effect of disinfectant solution is considered to be significant than artificial saliva or distilled water; From the values of solubility it can be inferred that the silicone liners performed better than the acrylics, with the heat cured silicone Molloplast-B exhibiting the lowest solubility values. It was concluded from the present study that the silicone liners exhibited superior properties compared to the acrylics in terms of solubility with the heat cured silicone showing lowest solubility. The self cured acrylic liner followed by the heat cured acrylic liner exhibited high solubility values. As there are changes in the values when compared to the previous studies there is need for the further studies to evaluate the solubility of different soft lining materials.

CONFLICT OF INTEREST & SOURCE OF FUNDING

The author declares that there is no source of funding and there is no conflict of interest among all authors.

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