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Water absorption and solubility of coated and non–coated silicone–based permanent soft liner

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الخلاصة

الأهداف: يهدف البحث إلى تحديد الفترة الزمنية التي يتطلبها نوع جديد من أنواع المواد الطرية المبطنة للطقم السليكونية الدائمة؛ لمقاومة الذوبان والامتصاص المائي، وتحديد تأثير المادة المغلفة على ذلك. **المواد وطرق العمل:** تم تحضير العينات من المادة المبطنة ووضعت في الماء وأختبرت بعد فترات زمنية هي: شهر، شهران، ثلاثة أشهر، وثمانية أشهر. نصف العينات غلفت بالمادة المغلفة الخاصة والمرفقة معا من المصنع، والنصف الأخر بقي غير مغلف. تم بعد ذلك تجفيف العينات بمادة (السلكا جيل) الخاصة للتجفيف ثم وزنت العينات بميزان الكتروني حساس. تم حساب الامتصاص والذوبان حسب معادلات عالمية معتمدة. الفروقات المعنوية تم تحديدها عن طريق الاختبارات الإحصائية: اختبار (تي) وتحليل التباين واختبار (دنكن) تحت تأثير فرق معنوي مقدار القيمة (بي) اقل من مستوى (0.05).**النتائج:** ليس هناك فرق معنوي إحصائي بين العينات المغلفة وغير المغلفة فيما يخص الذوبان والامتصاص المائي. كذلك لا يوجد فرق معنوي إحصائي لتأثير الفترات الزمنية على الذوبان والامتصاص المائي. أما تغليف العينات فانه يقلل نسبة الذوبان والامتصاص المائي لكن بمستوى غير معنوي. **الاستنتاجات:** المادة التي فحصت أثبتت مقاومة ممتازة للذوبان المائي لفترة زمنية طويلة (ثمانية اشهر). أما ما يخص امتصاص الماء فهو محدود ومقبول سريريا. في حين نجد أن تغليف المادة المفحوصة بالمادة المغلفة الخاصة حسن مقاومتها للامتصاص والذوبان بنسبة قليلة.

الكلمات المفتاحية: الامتصاص، الذوبان، التغليف، مادة التبطين الطرية.

ABSTRACT

AIMS: To determine the period of time that a new generation of silicone–based, chairside, permanent soft liner resist absorption and solubility and determine the effect of coating material. **MAERIALS AND MEHODS**: Specimens of (Mucopren soft) soft liner were prepared, stored in water, and tested after 1 , 2 , 3 , and 8 months. Half of the specimens were coated with coating material supplied by manufacturer and the other half remained uncoated. Silica gel was used for drying and sensitive electronic balance was used for weighing specimens. Universal formulas were used for calculating water absorption and solubility. T–test and ANOVA followed by Duncan multiple range test were used to determine the significant difference at $P<0.05$ level. **RESULS**: There was no statistically significant difference between coated and non–coated soft liner in relation to water absorption and solubility. There was no statistically significant difference in water absorption and solubility when comparing it among the periods of testing from the first month to the eighth months. Coating the soft liner decrease the percentage absorption and solubility of the silicone soft liner but this effect is statistically not significant. **CONCLUSIONS**: Mucopren soft– lining material has proved excellent resistance to solubility for a long period (8 months). Water absorption is limited and are clinically accepted. Coating (Mucopren soft) soft liner with coating material slightly improve the resistance to water absorption and solubility.

Key Words: absorption, solubility, coating , soft liner.

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INTRODUCTION

Soft liners have been used in dentistry for more than century. The most common problems encountered using soft liners are water absorption and solubility. These problems are associated with changes in the structure and properties of the material that result in swelling, distortion, support of Candida albicans growth, and stresses at the liner/denture interface that reduce the bond strength. During use, soft lining materials are immersed in saliva and during denture storage they are soaked in water or an aqueous cleansing solution. During such immersion, soft lining materials undergo 2 responses: plasticizers and other soluble components are leached out and water or saliva is absorbed.[1]

The international Sandarad Organization has issued two types of soft denture lining; those that are used inraorally for up to 30 days and those that maintain softness and elasticity for more than 30 days.[2] Saber–Sheikh *et al*., classified the soft denture lining materials according to their chemical composition into acrylic based (methacrylate systems) and rubbery systems which are similar to silicone type impression material and are basically polymers of dimehylsiloxane[3]. Fujii *et al*., classified soft lining materials according to their methods of curing into self–cured, heat–cured and light– cured linings[4]. Garcia and Jones classified soft denture linings according to their clinical indication into: short–term linings(tissue conditioners and functional impression), immediate linings (1–6 months), and long term linings (permanent linings more than a year)[5].

Gardner and Parr introduced a coating material which is a thin syrup– like mixture of semiset methyl methacrylate resin and termed (monopoly). They stated that coating temporary soft denture lining with this coating material would allow the lining to maintain its resilient characteristics for longer period of time and act as barrier preventing movement of component to or from the soft lining[6]. Dominguez *et al*., evaluated the effect of monopoly coating on the reduction of water absorption and plasticizers loss from the temporary soft lining immersed in water over a one month period, and they found that coated soft lining may have lost alcohol but did not absorb water. In addition, there was no loss of plasticizer over 30 days test period[7]. Anil *et al*., concluded that coating the soft liner is beneficial in reducing microleakage at the interface between liner and denture base[8].

It was claimed that room–temperature vulcanizing (RTV) silicone soft linings have been associated with high water absorption value[9,10]. Preliminary investigations demonstrated that room–temperature vulcanizing silicone soft lining material has favorable mechanical properties but high water absorption[10]. Braden and Wright theorized that the type of filler and the way that it is bonded to the polymer could be responsible for the high water absorption seen in the room–temperature vulcanizing silicone materials, and the heat–cured silicone materials could have better bonding to the filler. They also suggested that heat–cured silicone materials may exhibit greater cross–linking, and this, coupled with the application of pressure, produces a denser material. As a result no micropockets of water would exist within the material.[9] A further factor is that some soft liners are cross–linked using a mixture of silanes, and many silanes readily undergo hydrolysis with alcohol being a by–product. In general, alcohols are water–immiscible and may act as humactants as a result of hydrogen bonding. Thus any residual cross linking agent may contribute to water absorption.[11] Water uptake characteristics have been shown to vary widely, depending on type and composition of soft lining materials.[12]

For the reasons mentioned above, when the new generation of silicone–based soft liner (Mucopren soft) was introduced to the market (which is a permanent and is set at room temperature), it was interesting to study the characteristics of water absorption and solubility of it over a long period of time (8 months).

The aims from this research are to determine the period of time that a new generation of silicone–based, chairside, permanent soft liner maintain its durability and resist absorption and solubility; and determine the effect of coating material (which is proposed to promote a better seal and durability of soft liner) on water absorption and solubility.

MAERIALS AND MEHODS

The material used in this research is Mucopren soft (Kettenbach Dental, Germany) – which is permanently soft polyvinyl siloxane reline material. It is new practical cartridge system which makes the material easy to apply and dispense accurately. It is provided with a coating component similar to silicon, but with less viscosity.

Specimens prepared by mixing the base–catalyst cartridges with an auto mixing gun and set chairside according to manufacturer instructions.

The specimens were circular in shape with a diameter of 3 cm. One millimeter thick specimens were prepared in a mould comprising a 1 mm thick spacer.(13) Twenty specimens were used for evaluating absorption and the same used for evaluating solubility properties. Half of the specimens were coated by coating material supplied with the product from the manufacturer. The other half remained uncoated.

Initially, specimens were dried over silica gel in a desiccators (LEVOSIL, Italy) and weighed to an accuracy of 0.0001 g using sensitive electronic balance (A&d company limited, Japan). This was considered to be the initial weight of the specimen (W1). Specimens then were immersed in water . The specimens subsequently were removed from water after one month. Excess water was removed by blotting with filter paper and the weight of the specimen was recorded (W2). This represent the weight of the specimen after absorption of water. The amount of soluble materials lost was measured by drying the specimens in desiccators after each absorption cycle and recorded as (W3).

The procedure was repeated after intervals of one month, two months, three months, and eight months. The percentage of absorption and solubility were determined as follows: (14,11,15,16)

(1) absorption % = [(W2 – W3) / W1] * 100

(2) solubility % = [(W1 – W3) / W1] * 100

(3) where : W1= initial weight, W2 = weight after absorption, and W3 = final weight after desiccation.

Statistically mean values and standard deviation were calculated. t–test was carried out to determine the significant difference in each of absorption and solubility between the coated and non–coated soft liner at $P<0.05$ level of significance. While mean values of the effect of time on absorption and solubility were compared with ANOVA followed by Duncan multiple range test to determine the significant difference at $P<0.05$ level of significance.

RESULTS

Tables (1,2,3,4) showed that there were no statistically significant difference between coated and non–coated soft liner in relation to water absorption during each of the first, second, third and eighth month.

Table (1): t–test for absorption (comparison between coated and non–coated soft liner) for the first month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
–.021	18	.983	–.0025	.11652	–.24729	.24229

Table (2): t–test for absorption (comparison between coated and non–coated soft liner) for the second month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
–.396	18	.697	–.0449	.11343	–.28321	.19341

Table (3): t–test for absorption (comparison between coated and non–coated soft liner) for the third month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
1.032	18	.316	.1588	.15394	–.16461	.48221

Table (4): t–test for absorption (comparison between coated and non–coated soft liner) for the eighth month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
.582	18	.568	.1390	.23869	–.36245	.64049

There were no statistically significant difference in solubility between coated and non–coated soft liner during each of the first, second, third and eighth month (Tables 5,6,7,8).

Table (5): t–test for solubility (comparison between coated and non–coated soft liner) for the first month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
.506	18	.619	.0486	.09609	–.15327	.25047

Table (6): t–test for solubility (comparison between coated and non–coated soft liner) for the second month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
.091	18	.929	.0987	1.09044	–2.19223	2.38963

Table (7): t–test for solubility (comparison between coated and non–coated soft liner) for the third month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
.075	18	.941	.0833	1.10786	–2.24422	2.41082

Table (8): t–test for solubility (comparison between coated and non–coated soft liner) for the eighth month.

T	Df	Significant (2–tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
					Lower	Upper
.120	18	.905	.1296	1.07567	–2.13031	2.38951

Tables (9and 11) showed that there were no statistically significant difference in water absorption when comparing it among the periods of testing from the first month to the eighth months. There are no statistically significant difference solubility of the soft liner tested when comparing among the different tested periods (Tables 10 and 12).

Table (9): ANOVA test for absorption (comparison among the different periods tested)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.728	4	.682	6.563	.000
Within Groups	9.873	95	.104		
Total	12.601	99			

Table (10) : ANOVA test for solubility (comparison among the different periods tested)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.296	4	.074	.022	.999
Within Groups	322.623	95	3.396		
Total	322.920	99			

Table (11) : Duncan Multiple Rang Test for absorption (comparison among the different periods tested)

variable	Absorption %	Duncan group
Month 8	.2676	A
Month 1	.3853	A
Month 3	.4282	A
Month 2	.4477	A

Table (12) : Duncan Multiple Rang Test for solubility (comparison among the different periods tested)

variable	solubility %	Duncan group
Month 8	.0804	A
Month 2	.0862	A
Month 1	.0953	A
Month 3	.1715	A

Figure (1) showed that although coating the silicone soft liner decrease the percentage absorption but this effect is statistically not significant. Coating soft liner decrease the percentage solubility of silicone soft liner but as shown in Figure (2), this effect is statistically not significant.

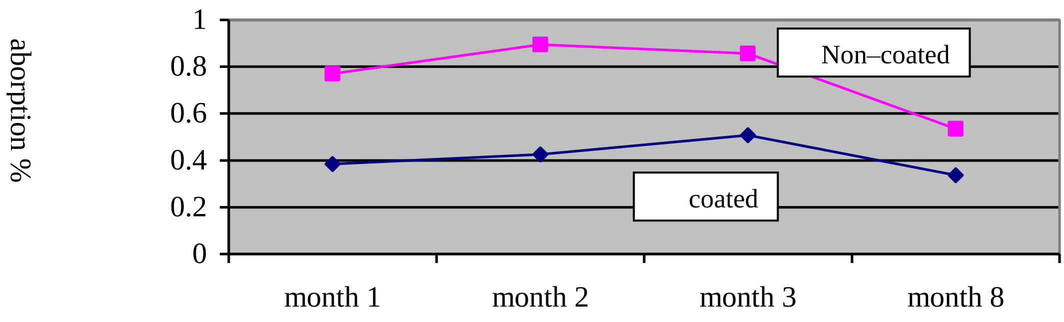

Figure (1): Percentage absorption of coated and non–coated soft liner

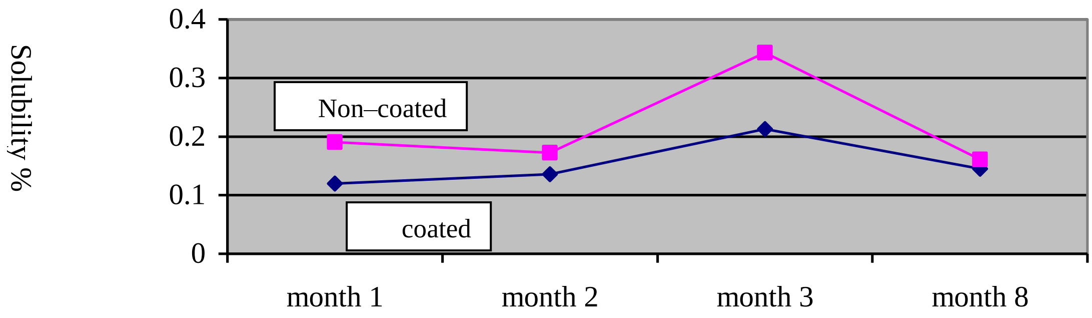

Figure (2) : Percentage solubility of coated and non–coated soft liner

DISCUSSION

The results of the present research indicated that the tested soft liner showed excellent resistance to water absorption and solubility over a long period of time (8months) and this is agree with El–Hadary and Drummond who concluded that an ideal soft liner should have no soluble components and low water absorption.[1]

The reasons for these results may be the amount and nature of the filler in the tested product (which may be low in quantity) and this is according to Waters et al who confirmed that silica filler was the major cause of water absorption.[11] Braden and Wright also stated that the nature of filler may have an effect on the rubber's water absorption. [9]

Another reason for the low water absorption and solubility of the tested material may be hydrophobic nature of the silicone soft liner. This is agree with Canay et al and Parker et al who found that the silicone–type materials absorbed less water than plasticized acrylics because of their high hydrophobic nature.[17,13]

Limited studies were carried out on the effect of coating material on water absorption and solubility of soft liner. The manufacturer claimed that coating material promote a better seal and durability of Mucopren Soft soft liner. In the present research, the effect of the coating material on the water absorption and solubility of silicone soft liner was performed and the effect was minimum. Although coating reduce absorption and solubility, but this effect is statistically not significant.

CONCLUSIONS

The new generation of permanent silicone–based soft liner (Mucopren soft) has proved excellent resistance to solubility for a long period of time (8 months). Although there are slight water absorption of (Mucopren soft) soft liner, but this is limited and are clinically accepted. Coating the (Mucopren soft) soft liner with special coating material slightly improve the resistance to water absorption and solubility (but statistically not significant).

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