The effect of different beverages on the surface roughness and hardness of soft denture lining materials

Farklı içeceklerin yumuşak astar maddelerinde sertlik ve yüzey pürüzlülük üzerine etkisi

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SUMMARY

Aim: The effect of different kind of drinks is to investigate on hardness and surface roughness of soft lining material.

Materials and methods: Eighty cylindrical soft liner specimens were produced for this study. Half of them were immersed in isobutyl methacrylate (iBMA) for 3 min. Specimens were then divided into four subgroups according to different beverages; water (control group), cola, soda, and orange juice. Surface roughness and hardness evaluation of the specimens were performed after 24 hours and 30 days of immersion. The obtained data were evaluated by analysis of variance followed by Tukey's test (p=0.05).

Results: In all groups, roughness and hardness values showed significant differences after both 24 hours and 30 days (p<0.05). The highest surface roughness and hardness values were detected in soda group of specimens, whereas water group of specimens were exhibited the lowest roughness and hardness values regardless of immersion time and iBMA.

Conclusion: Beverage as a habitual nutrition cause physical changes of dental soft liners.

Key words: Isobutyl methacrylate, hardness, soft denture liner, beverages, surface roughness.

ÖZET

Amaç: Farklı içeceklerin yumuşak astar maddesi üzerinde sertlik ve yüzey pürüzlülüğünün etkisini araştırmaktır.

Gereç ve yöntem: Bu çalışmada 80 tane silindir şeklinde yumuşak astar örnekleri hazırlandı. Örneklerin yarısı 3 dakika boyunca izobutil metakrilat (iBMA) içerisinde bekletildi. Daha sonra örnekler farklı içeceklere göre dört farklı alt gruba ayrıldı; su (kontrol grup), kola, soda ve portakal suyu. Örneklerin yüzey pürüzlülük ve sertliğinin değerlendirilmesi 24 saat ve 30 gün bekletildikten sonra yapıldı. Elde edilen veriler varyans analizi, Tukey's testi ile değerlendirildi (p=0,05).

Bulgular: Tüm gruplarda, hem 24 saat hem de 30 gün sonrasında pürüzlülük ve sertlik değerleri arasında farklılık önemli bulundu (p<0,05). En yüksek yüzey pürüzlülük ve sertlik değerleri soda grubunda görülürken, iBMA ve bekletme sürelerine bakılmaksızın su grubundaki örnekler en düşük pürüzlülük ve sertlik değerlerinde olduğu görüldü.

Sonuçlar: Devamlı tüketilen içecekler yumuşak astarlarda fiziksel değişimlere neden olur.

Anahtar kelimeler: Izobutil metakrilat, sertlik, yumuşak astar, içecekler, yüzey pürüzlülük.

INTRODUCTION

Denture soft lining materials, due to their viscoelastic properties, provide even distribution of functional loads on the denture-bearing area and avoid load stress concentrations.[1,2] They are used to provide a cushioning layer on the fitting surface of complete dentures in the management of traumatized oral mucosa, bruxism, residual ridge atrophy or resorp-

tion, relatively thin and non-resilient mucosa, and bony undercuts.[3]

There are two types of resilient materials: those based on acrylic resin and on silicone elastomers.[4,5] In the oral environment, silicone liners are more resistant to distortion, hardening and debonding from the denture base than acrylic liners.[4-6]

In the long term clinical use, soft denture liners have been featured with several problems associated with water absorption, loss of softness, distortion, surface deterioration, accumulation of plaque and debris.[7] Long-term softness is a desirable property of resilient liners. Soft lining materials are exposed to many conditions that may influence the hardness including denture disinfectants.[7] In addition, the release of ethanol and plasticizer causes liner's hardness due to water absorption and the leaching out of low molecular weight components.[8] Loss of softness can result in the delivery of greater occlusal forces to the underlying mucosa and increased clinical complaints.

On the other hand, the surface roughness of denture material and its implications for both microbial colonization and difficulty in the maintenance of denture hygiene is a particular concern. Therefore, the denture-fitting surface can act as a reservoir for microorganisms, and the use of removable dentures may be a predisposing factor for denture-related stomatitis.[9] It's therefore essential to investigate the roughness properties of soft denture liners.

Various studies have been carried out about the effects of water and denture cleansers on the properties of soft lining materials.[5-8,10] But there are few published articles with respect to the effect of beverages on the hardness and surface roughness of soft denture liners. Hence, this study was undertaken to investigate the hardness and surface roughness of denture relining materials after immersion of different beverages. The hypothesis tested was that beverages were not effective on the surface roughness and hardness of soft denture liners.

MATERIAL AND METHODS

A silicone-base soft denture lining material (Permaflex; Kohler, Neuhausen, Germany) and isobutyl methacrylate monomer (iBMA, Sigma-Aldrich Chemie GmbH, Buchs, Switzerland) were selected for this experimental study. Gypsum molds were prepared in denture flasks with cylindrical wax patterns, 10 mm in diameter and 10 mm in thickness for hardness test, 20 mm in diameter and 3 mm in thickness for surface roughness test. Permaflex and iBMA immersed permaflex (Permaflex+iBMA) placed into the molds. Trial closure was carried out by exerting 400 kp for 15 minutes and excess permaflex was trimmed off. Polymerization was performed according to the manufacture instruction, 2 hours in boiling water. The processed molds were cooled at room temperature for 20 minutes, and then placed under running tap water for 10 minutes. For Permaflex+iBMA specimens' preparation, 10 gr soft denture liner placed in a glass petri dish and fully covered with iBMA for 3 min.

Following fabrication procedure of the specimens, they were randomly divided into four subgroups (n=10) according to the different beverages; water, cola, soda, and orange juice. Each specimen was preserved in high-density polyethylene (HDPE) containers labeled with the name of the group. In addition, all containers were stored in distilled water at 37C° in a water bath (BM 302; Nüve, Ankara, Turkey). All media were replaced regularly on a daily basis in order to avert pH level changes.

Hardness and surface roughness of specimens were measured on the first day, and on the 30th day of the immersion. Hardness of the specimens were measured five times from different area by using analog shore A durometer tester (Tronic, South Korea), which was calibrated according to ASTM D2240. The shore value was calculated by averaging the 5 determined values and this process perform for each specimen.

The surface roughness value (Ra) was measured by using a profilometer (Surftest SJ-301, Mitutoyo, Japan) with a speed of 0.25 mm/s and a cut off wave lengths of 0.8 mm. For each specimen, five measurements were carried out and the Ra value was recorded as the mean value of five measurements.

The mean value and standard deviation of the specimens were statistically evaluated by Kolmogorov Simirnov, variance analysis and Tukey tests (α=0.05) by using a SPSS statistical software program (version 22.0, SPSS Inc., Chicago, IL, USA).

RESULTS

The mean values and standard deviations of surface roughness and hardness of the specimens after immersion in different beverages were presented in Table 1 and Table 2, respectively.

Analysis of data revealed that there was a direct proportion between surface roughness and immersion time. Moreover, significant difference between Permaflex and Permaflex+iBMA was detected in Soda group for both immersion times ($p<0.05$). Permaflex+iBMA groups had higher surface roughness values than Permaflex groups for both immersion times except 24 hours and 30 days of immersion in water.

After 24 hours and 30 days of immersion, hardness values significantly increased for all groups ($p<0.05$). The differences in hardness values for both materials (Permaflex and Permaflex+iBMA) were found to be significant regardless of immersion time ($p<0.05$).

Table 1: Means and standard deviations of the surface roughness mean values for soft denture liner specimens in tested beverages for 1 day and 1 month.

1 Day	Permaflex	Permaflex+iBMA	
Water	1.20 (0.30)[a]	1,08 (0,10)[a,b,c]	t=1.19 p=0.224
Cola	1.45 (0.26)	2.14 (0.57)[a]	t=3.43 p=0.003*
Soda	1.81 (0.53)[a,b]	2.55 (0.58)[b]	t=2.92 p=0.009*
Orange Juice	1.28 (0.27)[b]	2.24 (0.30)[c]	t=7.38 p=0.001*
1 Month			
Water	1.60 (0.29)[a,b,c]	1,54 (0,21)[a,b,c]	t=0.49 p=0.629
Cola	2.41 (0.55)[a]	2.78 (0.43)[a]	t=1.64 p=0.118
Soda	2.57 (0.45)[b]	3.20 (0.66)[b]	t=2.45 p=0.025*
Orange Juice	2.30 (0.39)[c]	3.10 (0.60)[c]	t=2.25 p=0.029*

*The difference between the groups (Permaflex and Permaflex+iBMA) were statistically significant within each row (p<0.05).
**Same superscripted lowercase letters indicate statistically significant means within each column (p<0.05).

Table 2: Shore A hardness mean values for silicone soft denture liner in varied beverages for 1 day and 1 month

1 Day	Permaflex	Permaflex+iBMA	
Water	40.90 (2.91)[a,b,c]	38.40 (1.94)[a,b,c]	t=2.25 p=0.037*
Cola	48.50 (2.36)[a]	52,75 (2.87)[a,d]	t=3.60 p=0.002*
Soda	49.55 (1.40)[b]	54.40 (2.14)[b,d]	t=5.72 p=0.001*
Orange Juice	47.40 (2.91)[c]	54.20 (3.44)[c]	t=4.90 p=0.001*
1 Month			
Water	40.90 (1,79)[a,b,c]	38.90 (2.95)[a,b,c]	t=1.81 p=0.087
Cola	49.70 (2.42)[a]	55.50 (2.29)[a]	t=5.48 p=0.001*
Soda	50.60 (3.01)[b]	56.30 (2.51)[b]	t=4.58 p=0.001*
Orange Juice	48.60 (2.15)[c]	54.90 (3.09)[c]	t=5.23 p=0.001*

*The difference between the groups (Permaflex and Permaflex+iBMA) were statistically significant within each row (p<0.05).
**Same superscripted lowercase letters indicate statistically significant means within each column (p<0.05).

DISCUSSION

The results obtained in this study clearly demonstrate that beverages significantly changed to both roughness and hardness of soft denture liners. Thus, the hypothesis was rejected.

In literature, many studies were performed at different immersion time in different beverage with or without anti-microbial agent of soft denture lining materials. Most of them were conducted on color changes, surface roughness and bonding properties to denture bases.[11-16] However, only two study was carried out on the effect of beverages on the hardness of the soft denture lining material and in that research Safari *et al.*[17] report that the hardness of the temporary acrylic soft lining materials more increased in water than alcohol and cola after 12 day immersion period. Stored in liquid media increased the hardness is in accordance with our research. On the other hand, we used water group as a control group and obtained the lowest hardness value, this is the contradiction and this might be caused by iBMA or different soft lining material. Leite *et al.*[15] report that the hardness of the silicone soft lining materials with direct technique were increased in beverages after thermal cycling. The results demonstrate parallel to our study.

While looking at the hardness and roughness values of the materials, there is no consensus regarding to the holding times in literature. Mese *et al.*[8] used 1 day, and 1, 3 and 6 months immersion periods in distilled water for the investigation of soft acrylic hardness. Furthermore, Kim *et al.*[18] researched on hardness and tensile bond strength of different soft denture liners after immersion of 1 day and 28 days in water. In addition, Safari *et al.*[17] preferred the waiting time of soft lining materials in different liquids for 12 days. Because of this diversity, we selected 1 and 30-day periods for our research.

Akin *et al.*[3] investigated the effect of application time (1 min and 3 min) of 2-hydroxyethyl methacrylate (HEMA) and iBMA on soft denture liner materials and they advocated that 3 min of iBMA immersion significantly increased the bonding properties of liner materials to denture bases. Hence, immersion time of 3 min was used in the present study.

Previous researches in the literature emphasized hardness value was in direct proportion to the time of immersion.[8,13,15,16,17] The result of the present study was in accordance with those of Mese *et al.*[8] and Kim *et al.*[18] who investigate the effect of immersion time on hardness. They mentioned the importance of duration and added liquids storage increased material hardness.

There is few study in the literature investigating the effect of beverages on the hardness and roughness of silicone soft liners but some researches were focused on the effect of antimicrobial agents and denture cleaners on the surface roughness of liner materials.[13,15,18,19] Garcia *et al.*[19] found that the highest hardness values were seen in water group of specimens and it was in direct proportion to immersion time. In accordance with Garcia *et al.*[19] Huddar *et al.*[13] found that denture cleaners resulted in lower surface roughness values than water and that truss span increased with time. However, in the present study, water had the least effect on roughness and hardness values.

CONCLUSION

Within the limitations of the study, both hardness and sur-

face roughness of the soft liner materials were negatively affected by different kinds of beverages and this adverse effect increased with time.

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