Dental Research Journal

Original Article

Effect of different mouthwashes on the shear bond strength and surface roughness of intraoral and heat-cured soft liners

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ABSTRACT

Background: The present study aimed to determine the effect of mouthwashes on the shear bond strength (SBS) and surface roughness (SR) of soft liners.
Materials and Methods: In this *in vitro* study, a total of 72 samples were prepared to evaluate the SBS (n = 36 for each liner). An autopolymerized (Mollosil Plus) and a heat-polymerized liner (Molloplast B) were injected in between two blocks of heat-processed acrylic resin (Triplex). The samples in each liner group were subdivided into three subgroups. Control group samples were totally stored in distilled water. In test groups, samples were immersed in chlorhexidine (CHX) or mouthwash containing ginger extract for 30 min daily. After 20 days, the SBSs were evaluated using a universal testing machine. To evaluate the SR, 30 disk-shaped samples (15mm*10mm) were prepared for each type of liners and stored in the similar solutions; distilled water, CHX and ginger mouthwash (n=10). SR was measured at 1 day and after 90 days with a profilometer. One-way ANOVA, independent t-test, and paired t-test were used to analyze data. $P < 0.05$ was considered statistically significant.
Results: The SBS in Molloplast B liner was significantly higher than Mollosil regardless of type of solution ($P < 0.001$). In both liners, the mean SBS was not statistically different between the three groups of solutions. Changes in SR were not statistically significant after 90 days, except for the Mollosil group, immersed in ginger extract solution which was increased ($P = 0.04$).
Conclusion: SBS of either group of liners did not change in both mouthwashes; However, SBS of heat-polymerized liner was higher than autopolymerized in all groups. Ginger extract-containing mouthwash increased SR of autopolymerized liner used in this study; whereas, there were no significant changes in the heat-cured liner. According to this study, CHX can be used for the disinfection of prosthesis lined with either type of liners.

Key Words: Dentistry, dentures, mouthwashes

Received: 04-May-2020
Revised: 12-Sep-2021
Accepted: 19-Dec-2021
Published: 16-Aug-2022

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INTRODUCTION

Liners are soft materials that are used to improve the adaptation of dentures and the condition of traumatized tissues. In general, these materials are classified into two categories: provisional soft liners (tissues conditioning materials) and permanent soft liners.[1] In another classification, the currently available liners are divided into two broad categories: silicone and acrylic, with each group being subdivided

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How to cite this article: Ghasemi S, Babaloo AR, Taghizadeh M, Kananizadeh Y, Sheikholeslami M. Effect of different mouthwashes on the shear bond strength and surface roughness of intraoral and heat-cured soft liners. Dent Res J 2022;19:63.

into self-cured and heat-cured subgroups.[1] These materials are usually marketed as a powder and a liquid, which are mixed to produce a gel that is soft and viscoelastic.[2] Permanent soft liners are usually used as a therapeutic intervention in patients who cannot tolerate stress produced by dentures. These liners distribute functional and parafunctional forces more properly due to their elastic behavior, resulting in the relaxation of the underlying tissues.[3] The use of these liners improves mastication and articulation and increases the retention and stability of the denture.[4-6] Soft liners can easily and quickly be colonized by microorganisms; however, antimicrobial mouthwashes can be used to prevent microbial colonization of denture surfaces. The selection of these mouthwashes should be based on their effect on microorganisms and the absence of any detrimental effects on the soft liners.[7] When the denture liners continually contact water and other liquids, they lose their mechanical and physical properties over time for two reasons: (1) due to the elimination of the plasticizer and other water-soluble agents and (2) due to the absorption of waster by polymers. These changes give rise to various problems with the use of soft liners, including the failure of the bond between the liner and the resin base of the denture (which will make it ineffective), loss of softness and elastic properties, *Candida albicans* colonization, and an increase in surface roughness (SR) (leading to microbial plaque accumulation).[8-10] A systematic review (2019) found that different mouthwashes have different effects on the mechanical properties of soft liners.[11] Therefore, selection of an appropriate disinfectant is necessary to decrease such changes.[12]

The present study aimed to evaluate the effect of chlorhexidine (CHX) mouthwash, which is useful in eliminating Gram-positive, Gram-negative, and *Candida* species[13] and a new antifungal herbal mouthwash containing ginger on the shear bond strength (SBS) and SR of denture liners.

The null hypothesis of this study was that the CHX and ginger mouthwash had no effect on SBS and SR of two soft liners.

MATERIALS AND METHODS

Shear bond strength

Each sample consisted of two Triplex Hot acrylic resin blocks (Ivoclar, Vivadent, Liechtenstein) (40 mm × 10 mm × 10 mm) that had been bonded together with an exact thickness (3 mm) of the soft liner. The blocks were fabricated using the compression mold technique with a special flask that could provide the desired dimensions. In another custom-made flask, the liner was injected between the two blocks[14] [Figures 1 and 2].

The samples were divided into two groups in terms of the type of the soft liner to evaluate the SBS of the samples; each group was subdivided into three subgroups in terms of the immersion solution: distilled water (the control), CHX mouthwash, and ginger extract mouthwash (a total of six groups, $n = 12$ in each group).

The SBS of two soft liners, the first one was a definitive silicon-based autopolymerized liner Mollosil Plus (DETAX, Germany) and the second one was a definitive silicon-based heat-polymerized liner Molloplast B (DETAX, Germany) bonded to Triplex Hot acrylic resin, were evaluated after immersion in two types of disinfecting agents: 0.2% CHX (Rozhin Co., Tabriz, Iran) and Ginger (Rozhin Co., Tabriz, Iran) mouthwashes.

The acrylic resin was mixed according to the manufacturer's instructions and packed into the flask. After the heat-curing process, the acrylic resin blocks were retrieved from the flasks, rinsed, and dried. The soft liner's special primers were applied on the dry surfaces of the blocks with the use of a clean brush. The acrylic resin blocks were placed in another mold [Figure 2] to bond the soft liners in between the acrylic surfaces. Finally, the samples were retrieved from the molds and after preparation, all were immersed in distilled water. One-third of the samples were immersed in 0.2% CHX solution once

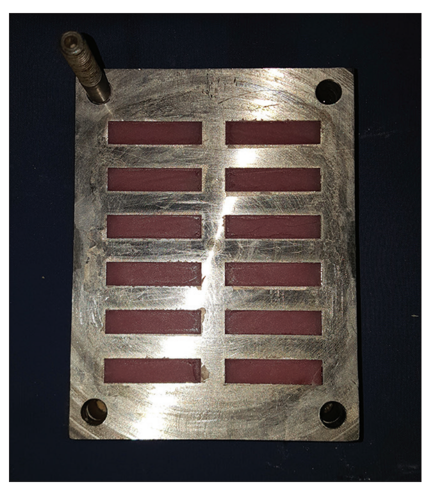


Figure 1: Packing of the acrylic resin into the special flask for preparation of the acrylic resin blocks.

daily for half an hour, and one-third of them were immersed in ginger extract solution once daily for half an hour. This procedure was repeated for 20 days. The remaining one-third of the samples severed as the controls. After 20 days, the SBS of the samples was measured in a universal testing machine (UTM, Hounsfield, H5KS, England) with a load of 500 kg at a strain rate of 5 mm/min. The samples were loaded until bond failure occurred, and the maximum SBS was recorded[10,14-17] [Figure 3].

Surface roughness

Ten samples in each subgroup were selected, totaling 60 samples.[17] The samples were manufactured in the form of soft liner disks, measuring 15 mm in diameter and 10 mm in thickness within a special flask with the same dimensions. The Mollosil Plus samples (a self-cured soft liner) were prepared by mixing an equal proportion of the base and catalyst according to the manufacturer's instructions and injected into the molds within the flasks. The base of the mold was placed on a glass slab covered with a layer of cellophane to facilitate separation. After the setting reaction of the material (7 min), the samples were retrieved from the mold, and the excess material was removed. In the Molloplast B group, heat curing was carried out according to the manufacturer's instructions: a holding time of at least 120 min between the termination of pressing and heat curing; a heat-curing time of 120 min after achieving the boiling point temperature; and the time required for cooling: 24 h. Immediately after preparing the samples, the SR of the samples was evaluated using a profilometer (Sharif Solar, Iran) [Figure 4] along the diameter of each sample. Then, all the samples were immersed in distilled water. One-third of the samples were immersed in CHX for 15 min a day, and one-third were immersed in ginger extract solution for 15 min a day for 90 days. The remaining one-third of the samples served as the controls. The SR of the samples was re-evaluated after 90 days of immersion, and the data were recorded in µm. Then, the results were compared.[18]

The normal distribution of data was checked with the KolmogorovSmirnov test (P = 0.2). For statistical analysis of SBS in two types of liners, independent-samples t-test was used for each solution group, and one-way ANOVA was used for comparison of the effect of solution type on SBS in two groups of liners. For evaluation of solution type on SR, one-way ANOVA was used, and for comparison of SR between day 1 and day 90, paired t-test is used. Data were analyzed using SPSS Statistics for Windows, version 17 (SPSS Inc., Chicago, Ill., USA) and $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 presents the descriptive data and statistical analysis on the SBS test. According to the Table, Mollosil liner exhibited the highest SBS in the distilled water group (100.4 ± 9.76 N); the CHX group exhibited the lowest SBS (91.31 ± 13.22 N). In addition, the Molloplast liner exhibited the highest (177.05 ± 19.82 N) and lowest (154.78 ± 23.25) SBS means in the distilled water and CHX groups, respectively. The independent t-test was used to compare the mean SBS values between the liners separately in each solution. The results showed that the liner type resulted in significant differences in the SBS values in each group

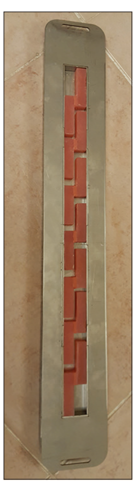


Figure 2: Preparation of the samples in a custom-made flask for the SBS test.

Figure 3: The shear bond strength test.

Figure 4: The profilometer.

of three solutions ($P < 0.001$). The mean values were compared between the different solutions separately in each liner with the use of one-way ANOVA. The results showed that the solution type did not result in a significant difference in the mean SBS between the two liners ($P = 0.423$ for Mollosil group and $P = 0.093$ for Molloplast group) [Table 1]. Graph 1a and 1b present the mean SBS values in terms of the groups and different liners.

Table 2 presents the descriptive data and statistical analysis of the SR in all groups of liner/solutions at 1 day and 90 days. According to the results of one-way ANOVA analysis, differences of mean SR values in each liner soaked in three solutions were not statistically significant in both time intervals (P values: Mollosil/day 1 = 0.138, Molloplast/day 1 = 0.821, Mollosil/day 90 = 0.978, Molloplast/day 90 = 0.159).

Comparison of the SR values at 1- and 90-day intervals with paired *t*-test in each liner/solution group showed that only Mollosil liner exhibited a significant difference in the ginger extract solution group ($P = 0.04$). Data of SR in different solutions and liners at 1- and 90-day intervals are presented in Graphs 2 and 3.

DISCUSSION

Soft liners are added to the inner surface of dentures to homogenously distribute forces and decrease pressures at certain points. Conventionally, disinfectants are used to prevent and manage microbial colonization in soft liners; however, an agent should be selected that does not disrupt the mechanical properties of soft liners,

Table 1: The descriptive statistics of the shear bond strengths in the different study groups

Group	Mean±SD		*P* (between liners)
	Mollosil (n/cm^2)	Molloplast (n/cm^2)	
Distilled water	100.4±9.76	177.04±19.82	<0.001
CHX	91.31±13.22	154.78±23.25	<0.001
Ginger	99.62±2023	157.23±20.13	<0.001
P (between solutions)	0.423	0.093	

SD: Standard deviation; CHX: Chlorhexidine

while it decreases or prevents changes due to its use. Therefore, the present study was undertaken to (1) compare the SBS of Mollosil Plus and Molloplast B soft liners to heat-cured acrylic resin after immersion in different solutions for 20 days, including distilled water, 0.2% CHX, and ginger extract solution, and (2) compare the surface of the two liners immediately and 90 days after immersion for 15 min daily in the above solutions.

According to the results, in both soft liners (heat cured and intraoral), the highest SBS was recorded in the distilled water group (the control), with the lowest in the CHX group. In the Mollosil Plus soft liner, the comparison of SBS between the ginger extract solution and CHX groups and the control group did not reveal any significant differences ($P = 0.42$). In the Molloplast liner, too, such a comparison with the control group showed a nonsignificant decrease in SBS ($P = 0.09$). The soft liner type resulted in a significant difference in the SBS ($P < 0.001$).

Concerning SR in the Mollosil liner group, the ginger extract solution resulted in a significant increase in this variable from day 1 to day 90 ($P = 0.04$). In addition, CHX mouthwash resulted in a nonsignificant decrease in SR in both liners ($P > 0.05$).

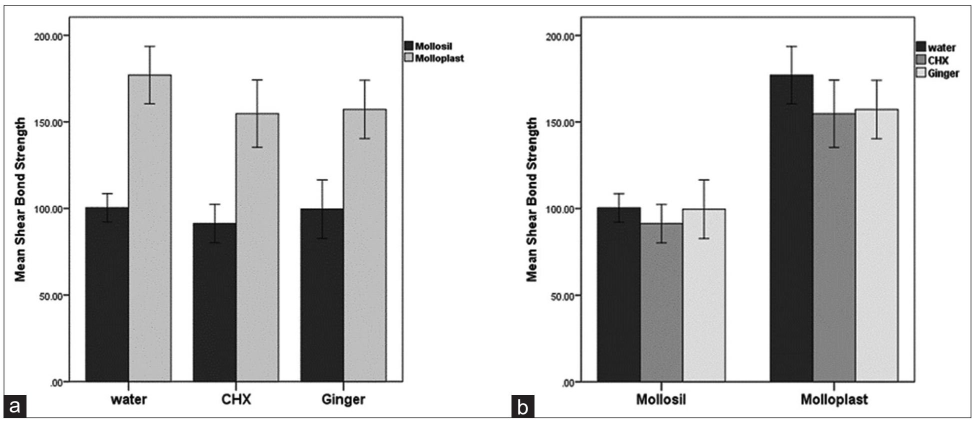
Several studies have evaluated the effects of different mouthwashes on the SR of soft liners and the bond strength of soft liners to the acrylic resin base. Mahboub *et al*. evaluated the effects of NaOCl and Corega on the shear and tensile bond strengths of GC soft liner. NaOCl significantly decreased the TBS and SBS of the GC soft liner compared to the control groups; however, Corega did not significantly affect the SBS and TBS compared to the control group.[10]

Geramipanah *et al*. evaluated the effects of 2.5% NaOCl and Corega on the tensile bond strength of Acropars, Molloplast, GC, and Mollosil soft liners

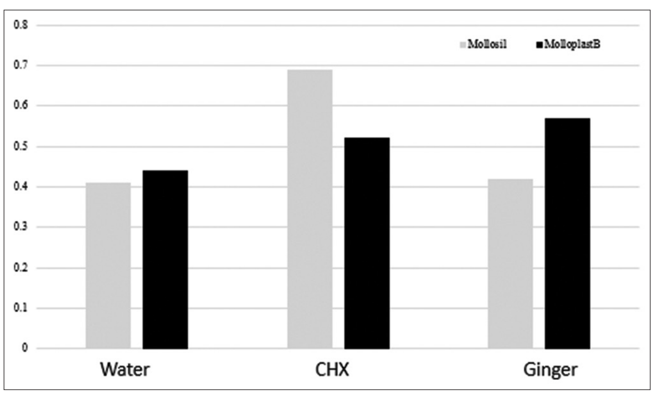
Table 2: The descriptive data of surface roughness in the different study groups

Liner	Group (solution)	Day 1, mean±SD (µm)	*P* (comparison between materials)	Day 90, mean±SD (µm)	*P*	
					Comparison between materials	Comparison before and after intervention
Mollosil	Distilled water	0.41±0.29	0.138	50.56±0.32	0.978	0.525
	CHX	0.69±0.19		0.6±0.26		0.531
	Ginger extract	0.42±0.14		0.65±0.14		0.04
Molloplast	Distilled water	0.44±0.35	0.821	0.51±0.16	0.159	0.739
	CHX	0.52±0.25		0.21±0.23		0.217
	Ginger extract	0.57±0.26		0.36±0.25		0.268

SD: Standard deviation; CHX: Chlorhexidine



Graph 1: (a). Comparison of the mean shear bond strengths of two soft liners in each solution. (b) Comparison of the mean shear bond strengths of each soft liner in different solutions



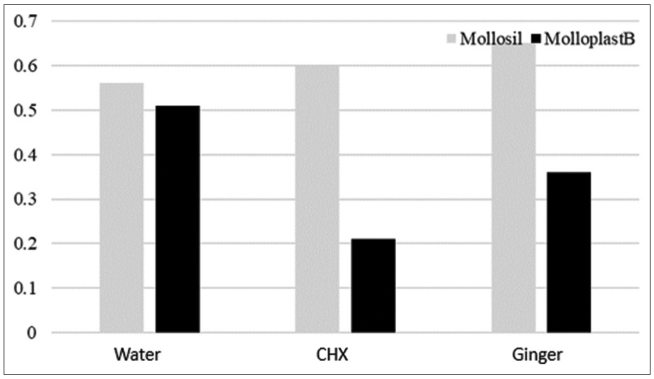
Graph 2: Comparison of the mean surface roughness of the different study groups on day 1.

and reported that there was a significant relationship between the soft liner type and the tensile bond strength: Acropars > Molloplast > GC > Mollosil. However, the effect of the solution type was not significant on the tensile bond strength of the samples.[15] In the present study, too, the liner type had a significant effect on the bond strength; however, immersion in different solutions did not result in significant differences in the bond strength of different liners.

Abdul-Razaq *et al*. evaluated the effects of 0.2% CHX and Solo solutions on the SBS, hardness, and SR of two soft liners (Mollosil and Viscogel). None of the solutions significantly affected the SBS and hardness of soft liners. In addition, 0.2% CHX significantly decreased the SR of Viscogel soft liner and nonsignificantly decreased the SR of Mollosil soft liner. The Solo solution, too, significantly decreased the SR of Mollosil soft liner. The results of the present study on the effect of CHX on the SBS and SR of soft liners are consistent with those of the study above.[19] Izumida *et al*. (2014) also found a reduction in roughness associated with brushing and disinfection with sodium perborate and/or CHX gluconate and related it to cross-linked agents that reduce the acrylic resin solubility in organic solvents.[20]

In general, differences in the behaviors of different soft liners in different solutions are factors that determine changes in the SR.

Pavarina *et al*. (2003) evaluated the effects of CHX solution and microwaves on the SR of five relining materials and reported that CHX increased the SR of the liners. The differences in the results of the study



Graph 3: Comparison of the mean surface roughness of the different study groups on day 90.

above and the present study might be explained by the different nature of the liner, the difference in the CHX concentrations, and the difference in the protocol of the use of CGX between the two studies.[17]

CONCLUSION

1. The SBS of the soft liners evaluated after immersion in CHX and ginger extract solution was not significantly different from that after immersion in distilled water
2. The SBS of the heat-cured soft liners (Molloplast B) was higher than that of the intraoral soft liner (Mollosil Plus)
3. The ginger extract-containing mouthwash increased the surface hardness of the intraoral soft liner (chairside), with no significant effect on the heat-cured soft liner
4. CHX mouthwash did not significantly affect the surface hardness of the two soft liners evaluated (Molloplast B and Mollosil Plus).

Therefore, 0.2% CHX mouthwash is recommended for the disinfection of both liners evaluated in the present study. However, the use of the ginger extract-containing mouthwash is recommended for the disinfection of heat-cured soft liner.

Financial support and sponsorship
Nothing

Conflicts of interest
The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

REFERENCES

1. Zarb GA, Hobkirk J, Eckert S, Jacob R. Prosthodontic Treatment for Edentulous Patients: Complete Dentures and Implant-supported Prostheses. 13rd ed. Toronto: Elsevier Health Sciences; 2013. p. 144-9.
2. Park SK, Lee YK, Lim BS, Kim CW. Changes in properties of short-term-use soft liners after thermocycling. J Oral Rehabil 2004;31:717-24.
3. Sarac D, Sarac YS, Basoglu T, Yapici O, Yuzbasioglu E. The evaluation of microleakage and bond strength of a silicone-based resilient liner following denture base surface pretreatment. J Prosthet Dent 2006;95:143-51.
4. Kimoto S, Kimoto K, Gunji A, Kawai Y, Murakami H, Tanaka K, *et al.* Clinical effects of acrylic resilient denture liners applied to mandibular complete dentures on the alveolar ridge. J Oral Rehabil 2007;34:862-9.
5. Kimoto S, Kimoto K, Gunji A, Kawai Y, Murakami H, Tanaka K, *et al.* Effects of resilient denture liner in mandibular complete denture on the satisfaction ratings of patients at the first appointment following denture delivery. Nihon Hotetsu Shika Gakkai Zasshi 2008;52:160-6.
6. Pisani MX, de Malheiros-Segundo AL, Balbino KL, de Souza RF, de Paranhos HF, da Silva CH. Oral health related quality of life of edentulous patients after denture relining with a silicone-based soft liner. Gerodontology 2012;29:474-80.
7. Sajjan P, Laxminarayan N, Prakash Kar P, sajjanar M. Chlorhexidine as an antimicrobial agent in dentistry a review. Oral Health Dent Manag 2016;15:4.
8. Meşe A. Bond strength of soft denture liners following immersion of denture cleanser. Biotechnol Biotechnol Equip 2006;20:184-91.
9. Brozek R, Rogalewicz R, Koczorowski R, Voelkel A. The influence of denture cleansers on the release of organic compounds from soft lining materials. J Environ Monit 2008;10:770-4.
10. Mahboub F, Salehsaber F, Parnia F, Gharekhani V, Kananizadeh Y, Taghizadeh M. Effect of denture cleansing agents on tensile and shear bond strengths of soft liners to acrylic denture base. J Dent Res Dent Clin Dent Prospects 2017;11:183-8.
11. Kreve S, Dos Reis AC. Denture liners: A systematic review relative to adhesion and mechanical properties. ScientificWorldJournal 2019;2019:6913080.
12. Singh K, Chand P, Singh BP, Patel CB. Study of the effect of surface treatment on the long term effectiveness of tissue conditioner. J Oral Sci 2010;52:261-5.
13. Mozayeni M, Hadian A, Bakhshaei P, Dianat O. Comparison of antifungal activity of 2% chlorhexidine, calcium hydroxide, and nanosilver gels against *Candida albicans*. J Dent 2015;12:109-17.
14. Alaa'a MS. Shear bond strength of three silicone lining materials bonded to heat-cured denture resin. King Saud Univ J Dent Sci 2013;4:17-20.
15. Geramipanah F, Haghighi AM, Zeighami S. Effect of denture cleansers on tensile bond strength of soft liners to denture base resin. J Islamic Dent Assoc IRAN 2013;25:172-9.
16. de Andrade IM, Cruz PC, Silva-Lovato CH, de Souza RF, Souza-Gugelmin MC, Paranhos Hde F. Effect of chlorhexidine on denture biofilm accumulation. J Prosthodont 2012;21:2-6.
17. Pavarina AC, Pizzolitto AC, Machado AL, Vergani CE, Giampaolo ET. An infection control protocol: Effectiveness of immersion solutions to reduce the microbial growth on dental

prostheses. J Oral Rehabil 2003;30:532-6.
18. Hilal SM, Singh S, Hari PA, Amarnath GS, Pasha N, Anand M. Evaluate the effect of commercially available denture cleansers on surface hardness and roughness of denture liners at various time intervals. Int J Biomed Sci 2016;12:130-42.
19. Abdul-Razaq RW. The effect of two types of disinfectant on shear bond strength, hardness, roughness of two types of soft liners. J Baghdad Coll Dent 2012;24:27-31.
20. Izumida FE, Jorge JH, Ribeiro RC, Pavarina AC, Moffa FB, Giampaolo ET. Surface roughness and *Candida albicans* biofilm formation on a reline resin after long-term chemical disinfection and tooth brushing. J Prosthet Dent 2014;112:1523-9.