Original Article

Effect of some disinfectant solutions on the hardness property of selected soft denture liners after certain immersion periods.

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Summary:

Background: Disinfection of denture and soft denture liners became among the priorities for cross contamination control as well as patient's health. All the trials aimed to have maximum infection control with minimal adverse changes in the materials properties.

Materials and methods: Discs of 30x2mm were made from Coe Super Soft and Coe Soft denture liners. Every 5 specimens were immersed separately and daily in CHX, Sodium hypochlorite and chlorine dioxide, control group specimens were immersed in the distilled water. Hardness property of the experimental and control groups was evaluated by using Shore A durometer after 1, 7, 30 days.

Results: Statistical analysis indicated non significant differences when the control group was compared with every disinfectant solution regarding tested periods, while ANOVA test showed significant differences among tested solutions after every testing period. Further LSD attributed these differences to the chlorine dioxide since it is the only solution that decreases hardness value after immersion.

Conclusion: Either of the tested solutions can be used safely regarding hardness property, although CHX and Sodium hypochlorite are more recommended since their effects on the hardness property was relatively same in comparison to the control.

Keywords: CHX, Sodium hypochlorite, Chlorine dioxide, hardness, soft denture liners.

Introduction:

Relining is the procedure used to resurface the tissue side of the removable dental prosthesis with a new base material, thus; producing an accurate adaptations the denture foundation area. (1) According to McCabe 1985(2), relining materials were divided into: 1-Hard reline materials. 2- Tissue conditioners. 3- Soft lining materials. Soft denture liners have been used for more than a century in dentistry. (3)They were classified by Philips 1982 into either plasticized acrylic resins or silicon rubbers, in each family the material was either heat cured or self cured. Dentures made from two different materials can only be successful if there is an adequate bond between the materials. Resilient liner materials have been used to provide cushion between the denture base and the supporting tissues (4) and allow for more uniform distribution of stresses at the mucosa/tissues interface, as well as it help in better distribution of the occlusal forces more evenly. (5)Among the benefits of this material is more undercuts engagement, treatment of patients with residual ridge atrophy, relatively thin mucosa, xerostomia and when the denture opposes natural dentition , likewise; resilient liners have been advocated in over denture therapy as a means of damping the forces of mastication(5,6) The ideal properties of the soft denture liners have not been determined, whereas properties such as biocompatibility, durability in oral environment and the ability to bond with denture base are obviously necessary; furthermore the longevity of the material is a major problem since it may be subjected to various mechanical stresses, water uptake and solubility. Oral environment and functional and parafunctional loads may alter or deteriorate some of the liner properties.(7) One of the physical property frequently assessed when comparing the quality of different lining material is hardness.Hardness as well as tensile properties are fundamental properties of rubber material; hardness is a simple way of obtaining a measure of the elastic material by determining the resistance to a rigid indenter to which a force is applied. Nevertheless, these properties can be affected when the material is submitted to daily immersion in denture cleansers or disinfectants.(5) Disinfection of denture base material (8) as well as denture liners was recommended as a method of reduction in the microbial contamination or growth and reduces oral infection as well as cross contamination.(9) In 1981 Addy and Handley (10) incorporated chlorhexidine into plasticized acrylic, they found out that hardness property and modulus of elasticity was reduced significantly after 87 days. Glass et al; 2004(11)concluded that single use of Medical tabs for denture and soft denture liner was effectively eliminate certain species of microorganisms including selected viruses. Further trials were done to disinfect soft denture liners by using microwave

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energy .Machado et al 2005 ;(12) found that using of microwave energy did not compromise the properties of soft liner. Disinfection by immersion in the disinfectant solution was suggested also; the results showed that denture cleansers did not affect hardness properties up to 6 months ; this was disagreed by Yilmaz et al ;2004 (9)who concluded that disinfection affected the physical properties of the soft denture liners including hardness property significantly.

Materials and Methods:

Materials used in this study are tabulated in table (1); it includes soft liner materials used and disinfectant solutions.

Table (1): Soft denture liners and disinfectant solutions

Soft liners	Polymerization method	Company
Coe Soft	Cold	GC lab. Tech.USA
Coe Super Soft	Hot	GC lab. Tech.USA
Disinfectants	Concentration	Time
CHX	2%	2 min.
Na. hypochlorite	2%	5min
Chlorine dioxide	0.5%	10min

CHX: chlorhexidine gluconate
Na. hypochlorite: sodium hypochlorite

Specimens Preparation: Testing specimens were cylindrical discs of 30 mm in diameter and 2 mm in thickness, prepared according to the manufacturer's instructions for every tested soft liner material(60 specimens for every tested material). Moulds were prepared by investing wax patterns of same dimensions in dental stone, figure (1), wax patterns were eliminated and materials were poured according to the manufacture's instructions, like the steps followed in the conventional denture construction technique. Figure (2) showed final specimens before testing stored in distal water.
Chlorhexidine disinfectant solution and chlorine dioxide were used in full strength as they supplied in the suggested concentrations while sodium hypochlorite solution was prepared every 14 days to insure stability and efficacy from 5.6 % stock solution(8).

Figure (1): Specimen's preparation, wax pattern invested in stone

Figure (2): Processed specimens stored in . distilled water.

Testing Procedures: The effect of disinfection procedure on the hardness property was evaluated by using Shore A durometer after 1 ,7 ,30 days .For each testing period , 40 specimens were prepared (20 for each soft denture liner, grouped into four groups -5 specimens for each disinfectant solution as well as the control).Each specimen was disinfected daily in the corresponding solution according to the suggested time and concentration, (table-1-) then rinsed with distilled water thoroughly and stored in a special container filled with distilled water till the testing time. Control group of the specimens were stored in the distilled water along the testing period.
During hardness testing, the specimen was supported by a glass slab and the indenter was allowed to penetrate the specimen , average of three different readings was taken as a testing value. The distance between the indenter and the specimen surface was fixed by 20mm and the contact time after penetration was 5 secs. The reading was taken directly from the scale reading representing hardness value. Figures (3) showed the device and testing procedure.

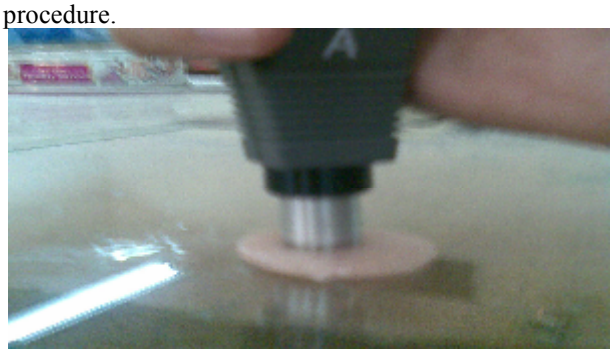

Figure (3): Specimen during testing

Statistical analysis:

1-Descriptive data include mean and standard deviation.

2-Student T-test to compare between the control with each of the experimental –disinfectants-groups at a level of significance

3-Oneway-ANOVA-analysis to compare between experimental groups.

Results:
All descriptive data are arranged in table (2), in this table means of the hardness values of five specimens with their standard deviation are tabulated.

Table (2): Descriptive data of different groups including means and standard deviation(S.D).

Disinfectants		Coe soft			Coe Super soft		
		1day	7day	30day	1day	7day	30day
CHX	Mean	39.12	39.96	43.94	74.16	74.90	83.56
	S.D	1.553	1.213	1.112	0.572	1.129	1.171
Na. Hypochlorite	Mean	38.88	41.200	52.56	73.98	75.12	88.22
	S.D	1.207	1.185	0.089	0.898	1.559	1.133
Chlorine dioxide	Mean	37.00	36.70	34.92	74.04	72.16	68.84
	S.D	0.790	0.620	0.923	0.798	0.507	2.052
Control	Mean	38.26	38.68	41.92	73.60	74.22	85.16
	S.D	0.181	0.858	1.215	0.505	0.432	1.574

Control versus Experimental groups:-
Student T-test was used to compare between the control and each of the disinfectant solutions regarding testing periods and materials, results are tabulated in table (3).

Table (3): t-test between disinfectants with control regarding soft denture liners and testing periods.

Disinfectant	Coe soft						Coe super soft					
	1day		7day		30day		1day		7day		30day	
	t-test	p. value	t-test	p. value	t-test	p. value	t-test	p. value	t-test	p. value	t-test	p. value
CHX	1.231	0.254	1.925	0.09	2.741	0.02*	1.640	0.140	1.258	0.244	1.823	0.106
Na. Hypochlorite	1.136	0.289	3.85	0.05	19.524	0.00**	0.825	0.434	1.244	0.249	3.313	0.01*
Chlorin dioxide	3.473	0..08	4.180	0.03*	10.25	0.00**	1.041	0.328	6.905	0.00**	14.108	0.00**

*P<0.05 Significant
**P<0.05 High significant

1-(Coe-Soft) soft denture liner
Control Vs CHX: The effect of daily disinfection of the Coe-Soft soft denture liner showed a non significant differences .Same results was shown when the material was disinfected after for 7 days. After 30 days of daily disinfection, there was significant difference between the control and CHX groups hardness values.
Control versus Sodium hypochlorite: Daily disinfection of Coe Soft specimens with Sodium hypochlorite does not affect hardness value up to the day 7, while 30 days disinfection showed high significant increase in Shore A durometer hardness value.
Control versus chlorine dioxide: Disinfection of the Coe-Soft specimen with chlorine dioxide for one time did not show significant changes in hardness value. Continuous disinfection of the material for 7 days reduced Shore A durometer value significantly. Statistical analysis showed a high significant differences in comparison with the control after 30 days disinfection with chlorine dioxide.
2-(Super-Soft) soft denture liner
Control Vs CHX: By using student T-test, hardness property after disinfection was compared, this analysis showed non significant differences even after 30 days of disinfection at a level of 0.05.
Control versus Sodium hypochlorite: Disinfection of Super Soft specimens after 1 or 7 days did not affect hardness property significantly. Prolonged disinfection up to 30 days affect the Shore A durometer value significantly.
Control versus Chlorine dioxide: Chlorine dioxide did not affect hardness property significantly after 1 day. Significant and high significant differences are shown after 7 and 30 days of disinfection respectively.
Experimental groups Oneway analysis:
Comparison between the effect of all disinfectant solutions was done by using F-test with further LSD analysis, results of this test is summarized in table (4).
1-(Coe-Soft) soft denture liner: Comparison between the three experimental disinfectant solutions by using F-test. This test showed significant differences after 1 day of disinfection with the solutions. Same test showed high significant differences between different disinfectants after 7days. High significant differences are shown after 30 days of disinfection. Further analysis by using LSD indicated that these differences are attributed to the action of the chlorine dioxide
2- (Super-Soft) soft denture liner: F-test with further LSD analysis were used to show the differences between effect of disinfectant solutions used to disinfect Super-Soft specimens after 1 day showed non significant differences while 7 days immersion showed significant differences, same effect was seen after 30 days of disinfection; these

changes are attributed mainly to the effect of chlorine dioxide.

Table (4): ANOVA between the disinfectants effect on hardness value.

Period	Coe-Soft			Super-Soft		
	F-value	P.Value	Significance	F-value	P.Value	Significance
1 day	4.498	0.035	S	0.041	0.932	N.S
7 days	24.835	0.00	H.S	10.289	0.02	S
30 days	389.02	0.00	H.S	208.185	0.00	H.S

N.S: not significant.
S: significant.
H.S: high significance.

Discussion:

From a theoretical standpoint, soft liners should be soft in order to distribute functional stresses on the residual ridge, and should be absorb energy during mastication to reduce transmission of these energy to the mucosa.(5, 13) Some soft liners can deform permanently,(14) whilst a small amount of deformation could be beneficial and allow the liner adapt to changes in the natural tissues, any significant changes can cause a denture to be unstable.(15)

A 2 mm thickness of soft denture liner was used in this study because it is recommended thickness mostly used clinically. Furthermore; hardness increase drastically when the material thickness was less than 2mm because a thickness less than 2 mm will reflect hardness of supporting material rather than soft liner itself. In the same way higher thickness can not be used because it interfere with the denture rigidity.(16)

Hardness is an important property for resilient material and should remain constant for a time depending on the type of the material whether permanent or temporary so that the material can efficiently fulfill their function. However; finding in the literatures showed variations or limited effect to time factor.(17)

The range of variations in the same property for different soft liner and different behavior of the material could be attributed to the chemical composition and/or polymerization method This in agreement with Arimo et al (1996)(18)and Leon et al (2005)(19) whom reported that presence of different component as cross linking agents may lead to improvement in some physical or mechanical properties(16). Furthermore; heat polymerization insure almost consumption of the monomer that enhance hardness and stability as in other properties while in autopolymerized material; resiliency mainly depend on the plasticizers, and since the bonding between the polymer's components is physical rather than chemical , this indicated the high resiliency and relatively low hardness values but this property is changed with the time which is mostly due to plasticizers leaching out(20) this also agreed by Parr and Rueggberg(2002)(21). Soft liners used in this study were acrylic based type, these material were preferable in their better adhesion property over silicone type since it was suggested that best bonding between two different material is when these materials were basically of identical chemical structure especially it was known that adhesion failure is the primary cause of soft liners limitation.(22). Changes in the hardness property after different time of disinfection might be explained by that currently acrylic soft liners have low hardness value after processing but degradation gradually increases hardness value as low molecular weight components are leached out from the material after elapsed time this in agreement with Terao (1993) (23). These changes could be attributed to either of the following factors:

1-Scission of the polymers chains.
2-Absorption of water.
3-Oxygen cross linking.
4-Leaching of plasticizers.

The first 2 factors could explain the decrease of hardness value because scission of polymer's chain may increase freedom of molecules movement while absorbed water may act as additional a plasticizers that enhance material resiliency, in the opposite direction the last two factors indicates reduction in molecules movements and reduces material elasticity.(24, 25).

Effects of the disinfectants: Sodium hypochlorite in a weak solution of 1% was used as a sanitizer for smooth surfaces; higher concentration is currently indicated for contaminated surfaces. A range of 2%-5.6% is good concentrations for dental disinfection procedures of dental stone, acrylics, endodontic irrigates. It's mode of action can be summarized as by adding hypochlorites to the water, hypochlorous acid (HOCl) is formed which is subsequently is divided into HCl and oxygen. The oxygen atom is strong oxidator that makes sodium hypochlorite strong disinfectant and effective against bacteria, viruses and fungi, in the same as chlorine does. Chlorine dioxide is a stronger oxidizer agent that currently used as a disinfectant especially in drinking water in a precise concentration. According to Haywood et al 2003(26); sodium hypochlorite did not affect hardness property of hard chairside reline material; this is disagree with the result in this study as well as with Yilmaz et al 2004(23), this could attributed to the different materials used in every test; cross linking agent; plasticizers ratio and curing method all might affect material's properties.

Statistical analysis by using T-test compare the effect of each disinfectant with the control indicated a non-significant differences; this means that either of the solutions used not affect hardness property by itself, indicating that either of the disinfectant used is good. In the same time comparison between disinfectants by using two way analysis of variance showed significant differences indicating variations in the action and effect of each disinfectant separately depending on the chemical composition and chemical activity. Addy and Handley 1981(10)whom also showed decrease in hardness property when CHX was used; the degree of reduction in hardness value was less which might be due to lesser CHX concentration. Chlorine dioxide decreased hardness value significantly in comparison with CHX and sodium hypochlorite this might be indicates that it produced some chemical- structural – alterations or damaging effect on the liners used. Generally chlorine dioxide is more potent than other solutions; further studies by using less concentrations or disinfection time might clarify our results.

Conclusions:

Either of the disinfectant solutions tested in this study is safe to be used for soft denture line disinfections in the tested concentrations and times, CHX and Sodium hypochlorite are more preferable in the disinfection procedure of soft denture liners since their effect on the hardness property is similar to the control group.

References:

1. *Glossary of Prosthodontic terms; 2005.8th ed. Mosby.*

2. McCab JF (1985): Anderson's applied dental material 6th ed. Blackwell scientific publication-London.

3. Mack PJ. (1989): Denture soft lining materials available.Aust.Dent J.34:517-521.

4. McCabe JF; Carrick TE; and Kamohara H. (2002): Adhesive bond strength and compliance for denture soft lining materials. Biomaterials; 23;; 1347-52.

5. Braden M; Wright PS; and Parker S. (1995): Soft lining material –A review. Eur. J. Prosthodont, Restor. Dent. 3:163-74.

6. Kiat-Amnuay S; Khan Z; and Gettleman L. (1999): Overdenture retention of four resilient liners over an implant bar. J. Prosthet. Dent. 81:568-573.

7. Saber-Sheikh K; Clarke RL. And Braden M. (1999): Viscoelastic properties of some soft lining materials. II. Aging characteristics. Biomaterials 20(21): 2055-2062.

8. Rasheed AH. (1997): Disinfection of acrylic resin cured by two different techniques.Master thesis .College of Dentistry. Baghdad University.

9. Yilmaz H; Aydin C; Bal BT; and Ocak F (2004): Effects of different disinfectants on physical properties of four temporary soft denture liner materials. Quintessence Int. 35(10):826-43.

***10.** Addy and Handley (1981): The effect of the incorporation of chlorhexidine cetate on some physical properties of polymerized and plasticized acrylics. J. Oral Rehabilitation 8(2): 155-63.*

11. Glass RT, Bullard JW, Conrad RS and Blewett EL, (2004): Evaluation of disinfection effectiveness of a denture cleaning product on denture contaminated with Known microbial flora. Quentessence Int.35(3): 194-9.

12.Machado AL, Breeding LC and Pukett AD (2005): Effect of microwave disinfection on the hardness and adhesion of two resilient liners. J. Prosthet. Dent.94(2): 183-9

13.Bajoury and Bassiouny;(2003): Effect of resilient liners on masticatory muscles activity of edentulous patients:- Clinical and electromyography studies, Gen. Den. 51950: 410-5.

14.van Zyl IP (1992): Creep compliance: a study of six commercially available soft denture liners.Master thesis, Am Arbor. University of Michigan, Micchigan.

15. Hekimo Glu and Anil N (1999): The effect of accelerated aging on the mechanical properties of soft denture lining materials. J Oral Rehabilit. 26(9): 745 .

16. Fujii K, Arikawa H, Kanie T, Kamiunten O and Miura K (2002): Effect of ethanol on the hardness and relaxation modulus of experimental photoactivated soft lining materials stored in aqueous solutions. J. Oral Rwhabilit. 29:770-776.

17.Malheiros-Segundo AL, Pisani MX, Paranhos HO, Souza RF, Siva- Lovato CH (2008):Effect of a denture cleansers on hardness, roughness and tensile bond strength of a denture liners. Braz. J. Oral Sci. 7(26):1596.

18.Arima T, Murata H, Hamada T(1996): The effect of cross linking agents on the sorption and solubility characteristics of denture base resins. J.Oral Rehabilit. 23:476-80.

19.Leon BL, Cury AA, Garcia RC (2005): Water sorption and tensile bond strengthof resilient denture lining materials polymerized by different methods after thermal cycling. J. Prosthet. Dent.93:282-7

20. Craige RG, Power JM and Wataha JC(2004): Dental Materials. Properties and manipulation. 8th ed. Mosby Inc.

21. Parr GR and Rueggberg FA (2002): In vitro, hardness, water sorption and resin solubility of laboratory processed and autopolymerized longe-term resilient denture liners over one year of water storage. J. Prosthetic Dent. 88(2):139-144.

22. Kutay O. (1994): Comparison of tensile and peel bond strengthof resilient liners. J. Prosthetic Dent. 71(5):525-31.

23.Terao T(1993): Physical and mechanical properties and endurance of denture base soft lining materials. J. Japanese Society for Materials and Devices 12:265.

24. *Wagner WC, Kawano F, Dootz ER, Koran A, III (1995): Dynamic viscoelastic properties of processed soft liners Part I Initial properties. J. Prosthet. Dent. 73: 471.*
25. Munksgarad EC (2004): Leaching of plastecizers from temporary denture soft lining materials. Eur. J. Oral Sci. 112(1):101-4.
26. Haywood J; Wood DJ; Gilchrist A; Basker RM and Watson CJ. (2003): A comparison three hard chairside denture reline materials .Part II .Changes in colour and hardness following immersion in three commonly used denture cleansers. Eur. J. Prosthodont. Restor. Dent. 11(4):165-9