



“EVALUATION OF HARDNESS OF SILICONE AND ACRYLIC RESIN BASED RESILIENT DENTURE LINERS OVER A PERIOD OF STORAGE IN WATER

Dental Science

Monica Kotwal

Aditi Sharma

Randhir Singh*

*Corresponding Author

ABSTRACT

Background: Two potential problems commonly identified with a denture base incorporating a resilient liner are a failure of the bond between the acrylic resin and resilient liner material and a loss of resiliency of the resilient liner material over time.

Methods: The current study was performed to assess the hardness of acrylic resilient liner in both auto-polymerized and heat-polymerized forms and silicone resilient liner in auto-polymerized form to a processed denture base resin over a period of water storage for 1 day, 1 week and 1 month. The denture liners investigated were acrylic resin-based heat-polymerized (Super-soft), acrylic resin-based autopolymerized (Coe-Soft) and silicone based autopolymerized (GC-reline) resilient liner. The resilient liners were processed according to manufacturer's instructions. Tensile bond strength was measured in ASI Instron universal testing machine at a crosshead speed of 20 mm/min, and hardness was measured using a Shore-A durometer.

Results: Two-way ANOVA and Tukey HSD tests were used to analyze the data ($\alpha=0.05$). The results indicated that there were significant differences both in the hardness and bond strength values of resilient liner materials.

Conclusion: Autopolymerized silicone resilient liner has increased hardness values than autopolymerized acrylic liner but the hardness values of autopolymerized silicone liner was less than heat cure acrylic resilient liner.

KEYWORDS

Relining, Hardness, resorption

INTRODUCTION

The success of a complete denture depends on the fit of the denture, occlusion, esthetics, and masticatory functions.¹The base of a complete denture is largely responsible for providing the prosthesis with stability, retention and support by being closely adapted to the oral mucosa. The material most commonly used for denture base is acrylic resin. Soft lining material is used to moderate the force of occlusion on supporting tissues. Resilient denture liner materials are applied to the intaglio surface of dentures to achieve more equal force distribution, reduce localized pressure, and improve denture retention by engaging undercuts. Although Ideal properties of resilient liners include resiliency over a long period of time, loss of softness occurs which results in the delivery of greater occlusal forces to the underlying mucosa and increased clinical complaints.² A study was conducted to assess the hardness of acrylic resin based auto-polymerized and heat-polymerized soft liners, and silicone based auto-polymerized resilient liner to a processed denture base acrylic resin over a period of water storage for 1 day, 1 week and 1 month.

MATERIALS AND METHODS

Three commonly used commercial resilient liner materials including types based on chemical composition i.e., Acrylic in both auto polymerized (COE-Soft) and heat polymerized forms (GC-Super-Soft) and Silicone based resilient liners (GC-Reline) in auto polymerized form were used for the investigation. Two brass dies of the dimension 20 mm in diameter and 12 mm height were invested in silicone rubber material and the mold was prepared (Fig-1&2). Ninety (90) cylindrical wax specimens of the same dimensions were obtained from the putty mold (Fig-3). All wax specimens were invested in dental plaster using conventional denture flasks and dewaxing was done in a conventional manner. After the elimination of the wax, the resilient liner was mixed, trial packed and polymerized in the plaster mold according to the manufacturer's instructions. After polymerization, the specimens were removed from the flask and trimmed with a sharp blade. Ninety specimens were collected thirty (30) each for GC-Reline, COE-SOFT, GC-Super Soft and designated GROUP A, GROUP B, GROUP C, respectively. In each group, 10 specimens each were stored in water at 37°C for 1 day, 1 week and 1 month. Hardness test for GROUP A&B was determined using Shore-A Durometer tester and was recorded.

The difference in the hardness of each resilient liner material was determined for the 3 test periods (A) and were evaluated statistically using a 2-way ANOVA and the Tukey HSD post hoc test. All statistical testing was performed at a preset alpha level of 0.05.

RESULTS

There were significant interactions between materials and time periods with respect to hardness, as shown by the 2-way ANOVA (Table II). Mean value and standard deviation of hardness of resilient liner materials for the three time intervals are given in Table I. There were significant differences in hardness between the materials at each time period, as shown in (Table II). The results of the hardness test demonstrated that the mean hardness (SD) of the heat-polymerized resilient liners after 1 day 37.50 (± 2.06) Shore was significantly ($P<0.05$) greater than that of autopolymerized liners 7.80 (± 2.04) Shore; 28.90 (± 3.10) Shore in the acrylic resin- and silicone-based groups, respectively. For super soft there was significant difference observed between 1 day and 1 week, 1 week and 1 month. For Coe-Soft, there were significant differences between 1 day and 1 week, 1 week and 1 month. For GC-reline soft, there were significant differences between 1 day and 1 week, 1 week and 1 month.

The lowest hardness values were seen in the specimens stored in the water for 24 hours, followed by the specimens stored for 1 week. Hardness values of the specimens were higher as the storage time increased. The highest hardness values for all resilient liner materials were observed after 1 months of storage. Considering the different types of material, the change was greater in the autopolymerized versus the heat-polymerized resilient liner materials. The mean hardness (SD) of Super soft acrylic resin-based resilient liners 37.50(± 2.06) Shore was significantly greater than that of GC soft reline silicone-based liners 28.90(± 3.10) Shore and COE soft acrylic based liners 7.80(± 2.04) Shore within the heat and autopolymerized group at 1 day period. The change in hardness over time for the acrylic resin-based resilient liner materials was greater than for the silicone-based liner materials within both the heat- and autopolymerized groups.

There are significant difference in pair wise comparison of groups and time periods with respect to hardness values as shown by Tukey HSD post hoc test (Table IV). In Super Soft group, the hardness values at 5% level ($p<0.05$) was significantly higher for all storage periods as compared to COE-Soft and GC-Reline soft liner with different follow-ups. In COE-Soft group, the hardness values for all storage periods at 5% level ($p<0.05$) was significantly smaller as compared to Super Soft and GC-Reline group with different follow-ups. Whereas in GC-Reline group, the hardness values at 5% level ($p<0.05$) was significantly higher as compared to COE-Soft but lower when compared to Super Soft group for all storage periods with different follow-ups.

Discussion

The composition Acrylic resin-based resilient liner is proprietary, but these materials generally include methacrylate polymers and copolymers, along plasticizers (ethyl alcohol and/or phthalate). The plasticizer lowers the glass transition temperature of the polymer to a value below mouth temperature so that the modulus of elasticity of the resilient material is reduced to a satisfactory level. Softness is primarily affected by the leaching out of plasticizer with a consequent hardening of the material, limiting its usefulness.³ On the other hand Silicone-based resilient liners don't need plasticizers to produce a softening effect with this material.²

The tests employed in this study apply different forces than those to which the resilient denture lining materials are subjected clinically; however, this in vitro study could provide preliminary information regarding the materials. The definitive heat-polymerized acrylic resin-based Super Soft liner had the greatest hardness compared with the other materials at 24 hours after immersion. These results concur with those of Dootz.⁴ Super Soft liner were harder than the interim autopolymerized acrylic resin-based Coe-Soft liner and definitive autopolymerized silicone-based GC Reline soft liner. The results confirm those of Polyzois and Frangou,⁵ who reported that heat-polymerized liners are harder than autopolymerized products.

The hardness values of all the resilient liner materials evaluated were higher with increased duration of immersion. The results of the current study were in agreement with those of other researchers, who reported that water storage increased resilient liner hardness in acrylic resin-based products more than in silicone-based products. The initial softness was due to the quantity of plasticizer in the liquid, since plasticizers are responsible for maintaining the softness of the acrylic resin-based resilient liner materials.⁴ Hardening of the acrylic resin-based resilient liners is proportional to the duration of immersion. Silicone-based resilient liners have superior elastic recovery, and their softness is controlled by the amount of cross-linking in the rubber; thus no plasticizer is necessary to produce a softening effect.¹ In addition, the hardness values of the COE-Soft and GC Reliners demonstrated greater change than that of the super soft liners over the duration of the current study. These findings agree with those of Qudah⁵ and Hekimoglu.⁶

Material selection is influenced not only by the properties offered but also by the particular treatment situation. The results of the present investigation support a common trend reported in previous studies namely, heat-polymerized silicone based resilient liners have more optimal properties.^{7,8} Heat polymerized acrylic resin-based resilient liners have good properties initially, but deteriorate with long-term use, and autopolymerized resilient liners have a useful, but limited role.

Conclusion

Autopolymerized silicone resilient liner has increased hardness values than autopolymerized acrylic liner but the bond strength and hardness values of autopolymerized silicone liner was less than heat cure acrylic resilient liner.

Table I: Mean (SD) values of hardness values of resilient liner materials for 3 time intervals (n=10) in three groups

Group	Super-soft (heat cure acrylic liner)		COE-Soft (self cure acrylic liner)		GC-Super soft (self cure silicone)	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
1 Day	37.5000	±2.0683	7.8000	±2.0440	28.9000	±3.1073
1 Week	45.0100	±3.6171	17.6100	±1.1474	28.7000	±1.1595
1 Month	49.1320	±1.8301	20.3000	±2.5495	29.9800	±1.4935

Table II: Two-way ANOVA results for comparison of hardness values between groups and time

SV	DF	SS	MSS	F-value	P-value
Main effects					
Group	2	12309.8506	6154.9253	1205.9193	0.0000*
Time	2	1104.6887	552.3444	108.2195	0.0000*
2-way interactions					
Group x time	4	466.1827	116.5457	22.8345	0.0003*
Error	81	413.4182	5.1039		
Total	89	14294.1402			

*p<0.05

Table III: Pair wise comparison of groups and time periods with respect to hardness values by Tukey HSD post hoc test

Group x time	Super-soft 1 day	Super-soft 1 week	Super-soft 1 month	COE-Soft 1 day	COE-Soft 1 week	COE-Soft 1 month	GC-Super Soft 1 day	GC-Super Soft 1 week	GC-Super Soft 1 month
Mean	37.500	45.010	49.132	7.800	17.610	20.300	28.900	28.700	29.980
Super-soft 1 day	-								
Super-soft 1 week	P=0.001*	-							
Super-soft 1 month	P=0.001*	P=0.0033*	-						
COE-Soft 1 day	P=0.001*	P=0.001*	P=0.001*	-					
COE-Soft 1 week	P=0.001*	P=0.001*	P=0.001*	P=0.001*	-				
COE-Soft 1 month	P=0.001*	P=0.001*	P=0.001*	P=0.001*	0.1782	-			
GC-Super Soft 1 day	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	-		
GC-Super Soft 1 week	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	0.9987	-	
GC-Super Soft 1 month	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	0.9771	0.9380	-

*p<0.05

Table IV: Comparison of 1day, 1week and 1 month values in each group with hardness by paired t-test

Group	Time	Mean	Std.Dev.	Mean Diff.	SD Diff.	Paired t-value	p-value
Super-soft	1 Day	37.5000	2.0683	-7.5100	3.5300	-6.7277	0.0001*
	1 Week	45.0100	3.6171				
	1 Day	37.5000	2.0683	-11.6320	1.9733	-18.6409	0.0000*
	1 Month	49.1320	1.8301				
COE-Soft	1 Day	7.8000	2.0440	-9.8100	1.9439	-15.9585	0.0000*
	1 Week	17.6100	1.1474				
	1 Day	7.8000	2.0440	-12.5000	3.4075	-11.6004	0.0000*
	1 Month	20.3000	2.5495				
GC-Super soft	1 Day	28.9000	3.1073	0.2000	3.1903	0.1982	0.8473
	1 Week	28.7000	1.1595				
	1 Day	28.9000	3.1073	-1.0800	2.4724	-1.3813	0.2005
	1 Month	29.9800	1.4935				
GC-Super soft	1 Week	28.7000	1.1595	-1.2800	1.7287	-2.3415	0.0439*
	1 Month	29.9800	1.4935				

*p<0.05

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