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THE EFFECT OF DENTURE BASE SURFACE TREATMENTS ON TENSILE BOND STRENGTH OF AUTOPOLYMERIZING AND HEAT CURE SILICONE RESILIENT LINERS

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ABSTRACT

Purpose of this study was to evaluate the effect of sandblasting, monomer treatment and combined effect of sandblasting and monomer treatment of conventional denture base resin on tensile bond strength of heat and auto cure silicone soft liners. Two resilient liners Auto cure (Mollosil) and Heat cure (Molloplast- B) were selected. Fifty six samples with cross sectional area of 25 × 25 mm were prepared and divided into two groups (Group A heat cure and Group B auto cure). Each group was further divided into 4 subgroups (7 samples in each subgroup) dependent upon the surface pretreatment. Subgroup 1 was control group (no surface treatment), subgroup 2 samples were surface treated by sandblasting (250 µm alumina particles), subgroup 3 samples were treated with monomer (for 180seconds), subgroup 4 samples were given combined treatment with sandblasting and monomer. Resilient liners were processed between 2 poly methyl methacrylate surfaces, in the dimensions of 3 mm. Tensile bond strength was determined with Instron Universal testing machine, at a cross head speed of 5mm/min. The data were analyzed using one-way ANOVA, followed by Tukey HSD test ($\alpha = 0.05$).Monomer and combined treatment significantly increased the tensile bond strength when compared with control. Sandblasting treatment significantly decreased the tensile bond strength when compared with control.

Keywords: Resilient liners, Bond strength, Denture base resins

INTRODUCTION

Esthetics, Comfort and Function are the three factors that determine the success of the complete or partial denture.[1] The precision of the fit of a denture is a crucial determinant in the retention. Nevertheless, inadequacy in the fit of the prosthesis is highly dependent on the irreversible process of alveolar resorption.[2] The forces exerted during mastication straightly relay on the basal mucosa which causes more stress on the alveolar ridge which results in irritation and soreness over the basal seat due to compression of fragile mucosa by the firm denture base which may occur early after the operative procedures. Therefore, under such circumstances it becomes highly essential to line the inner surface of the denture with a soft material analogous to the mucosa to pay up for the lost thickness and viscoelastic behavior of mucosa.[3] Currently, soft liners are available as silicon elastomers and plasticized acrylic resin in chemical and heat polymerized forms.[4] Silicon soft liners posses their elasticity during the whole of its working life because of its inherent property of polymer.[5] Soft liners are widely used on the dental prosthesis in the management of weak, irritated and non-resilient tissues and are capable to restore health to the deformed mucosal tissues by constantly spreading functional

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the flask after the curing. The acrylic blocks were then retrieved from flasks and finishing and polishing was done. Dimensions were measured with vernier caliper to verify the accuracy. The surfaces of the blocks to be bonded to liner were cleaned with fine grit sandpaper of number 320. After finishing and polishing, 112 blocks were randomly divided into 2 groups, each group contained 56 blocks to fabricated 28 specimens per group. GROUP A and GROUP B consist of 28 specimens each. Where each specimen is made of Two resin blocks joined by self cure silicone soft liner and heat cure silicon soft liner for group A and group B respectively . Each group was further divided into 4 subgroups with 7 specimen and 14 blocks each. SUBGROUP 1: Control group, i.e. the surfaces of blocks were left untreated. SUBGROUP 2: Surfaces of blocks to be bonded to liner were treated by sandblasting with alumina particles. The nozzle measuring about 1.0 mm in diameter was held in light contact with each specimen and moved across the specimens for 30 seconds with 250μm aluminium oxide particles as the sandblasting medium at a pressure of 0.62 Mpa. After the surface preparations, all specimens were placed in an ultrasonic cleaner and distilled water for 10 minutes to remove any residue remaining on the prepared surfaces. SUBGROUP 3: Surfaces of blocks to be bonded to liner were swabbed with the monomer and remained wet for 180 seconds. SUBGROUP 4: Surfaces of blocks to be bonded to liner were first treated by sandblasting as described above and then with monomer for 180 seconds. To fabricate the specimen for FOR GROUP A: mollosil adhesive was put onto the dried surfaces of both blocks to be bonded with liner for only 1 minute. The two acrylic cylinders were then placed in the lower part of metal mold with 3mm of space in between. Soft liner was then mixed homogeneously by taking equal lengths of base and catalyst material in the ratio of 1:1 and packed bubble free material in space with clean spatula (Figure. 2). The upper part of the custom mold

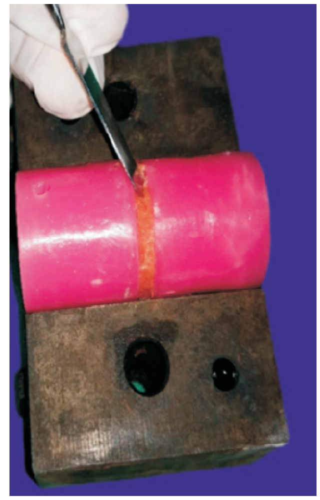

Figure 2

was then placed over it and bench-pressed for about 10-15 minutes at 100kvp. Once material was set, specimens were removed from the mold and excess was trimmed using BP Blade. FOR GROUP B, Primo adhesive was evenly put using a brush once or twice onto the surface of the blocks prepared. Air dry the blocks for one and a half hours and the two acrylic cylinders were then placed in the lower part of metal mold. Heat cure soft liner was taken using a spatula and packed into space between two acrylic cylinders (figure. 2). The upper part of the custom mold was then placed over it followed by bench pressing the specimens for 15 minutes at 100 kvp. The flask was placed into cold water and heated steadily up to 100°C, it was further kept for 2 hours at 100 degree celcius for the polymerisiation. Cooling of flask was done slowly. After which, the specimens were separated from the mold and excess was trimmed using BP Blade.

After curing, specimens were stored in artificial saliva till testing is done. Specimens of both the groups were tested. The universal testing machine was used to test the samples with maximum capacity (50,000 N) and extension (1200 mm) (figure. 3). Test was performed at a crosshead acceleration (5mm/min) till breakdown and the Tensile bond strength was evaluated for all specimens.

RESULTS:

Means and standard deviations for Mollosil and Molloplast-B are reported in Table 1; Maximum mean tensile bond strength was observed with monomer treated subgroup in both autocure and heatcure groups. One-way ANOVA (Table 2) revealed significant differences among various surface treatment subgroups of Mollosil (*P*<.001) except monomer surface treatment and combined surface treatment which showed insignificant differences. One- way ANOVA (Table 3) revealed significant differences among various surface treatment subgroups for Molloplast-B (*P*<.001) except in tensile bond strength of monomer surface treatment and combined surface treatment where difference was not significant. Mean tensile bond strength of Molloplast-B in all surface treatment groups was significantly higher than Mollosil (Table 1). Overall results is shown through the bar diagram. (Figure 4)

Table 1: Mean and Standard deviations for Mollosil and Molloplast-B and comparison of their surface treatment groups

		N	Mean	Std. Deviation	Mean diff	P-value
Control	Autopolymerizing	7	0.8486	0.14860	-0.42857	<0.001
	Heat Cure	7	1.2771	0.32056		
Sandblasting (S)	Autopolymerizing	7	0.4257	0.13746	-0.51714	<0.001
	Heat Cure	7	0.9429	0.09304		
Monomer (M)	Autopolymerizing	7	1.4386	0.17024	-0.66143	<0.001
	Heat Cure	7	2.1000	0.11804		
Combined (S+M)	Autopolymerizing	7	1.3200	0.15000	-0.74571	<0.001
	Heat Cure	7	2.0657	0.10114		

Table 2: Result of one-way ANOVA for tensile bond strength (MPa) between various surface treatment subgroups of autopolymerizing silicone resilient liner (Group A)

ANOVA					
	SS	df	MS	F	Sig.
Between Groups	4.530	3	1.510	65.334	.000
Within Groups	.555	24	.023		
Total	5.085	27			

Post hoc test		Tukey HSD				
(I) Subgroup	(J) Subgroup	MD (I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control (1)	sandblasting	.42286*	.08127	.000	.1987	.6470
	monomer	-.59000*	.08127	.000	-.8142	-.3658
	combined	-.47143*	.08127	.000	-.6956	-.2472
Sandblasting (2)	control	-.42286*	.08127	.000	-.6470	-.1987
	monomer	-1.01286*	.08127	.000	-1.2370	-.7887
	combined	-.89429*	.08127	.000	-1.1185	-.6701
Monomer (3)	control	.59000*	.08127	.000	.3658	.8142
	sandblasting	1.01286*	.08127	.000	.7887	1.2370
	combined	.11857	.08127	.477	-.1056	.3428
Combined (4)	control	.47143*	.08127	.000	.2472	.6956
	sandblasting	.89429*	.08127	.000	.6701	1.1185
	monomer	-.11857	.08127	.477	-.3428	.1056
*. The mean difference is significant at the 0.05 level.						

Table 3: Results of one-way ANOVA for tensile bond strength (MPa) between various surface treatment subgroups of heat cure silicone resilient liner (Group-B)

ANOVA					
	SS	df	MS	F	Sig.
Between Groups	7.020	3	2.340	69.042	.000
Within Groups	.813	24	.034		
Total	7.834	27			

POST HOC TESTS			**Tukey HSD**			
(I) Subgroup	(J) Subgroup	MD(I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
control	sandblasting	.33429*	.09841	.012	.0628	.6058
	monomer	-.82286*	.09841	.000	-1.0943	-.5514
	combined	-.78857*	.09841	.000	-1.0600	-.5171
sandblasting	control	-.33429*	.09841	.012	-.6058	-.0628
	monomer	-1.15714*	.09841	.000	-1.4286	-.8857
	combined	-1.12286*	.09841	.000	-1.3943	-.8514
monomer	control	.82286*	.09841	.000	.5514	1.0943
	sandblasting	1.15714*	.09841	.000	.8857	1.4286
	combined	.03429	.09841	.985	-.2372	.3058
combined	control	.78857*	.09841	.000	.5171	1.0600
	sandblasting	1.12286*	.09841	.000	.8514	1.3943
	monomer	-.03429	.09841	.985	-.3058	.2372

*. The mean difference is significant at the 0.05 level.

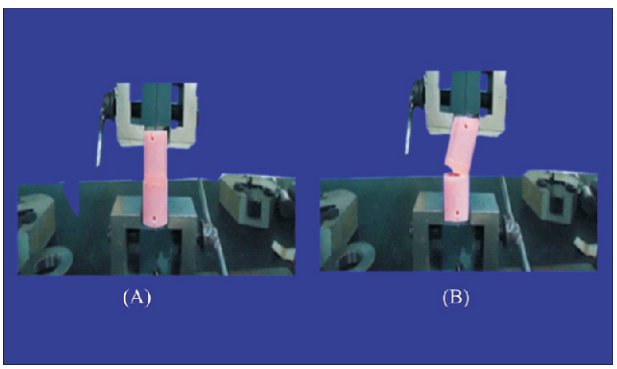

Figure 3

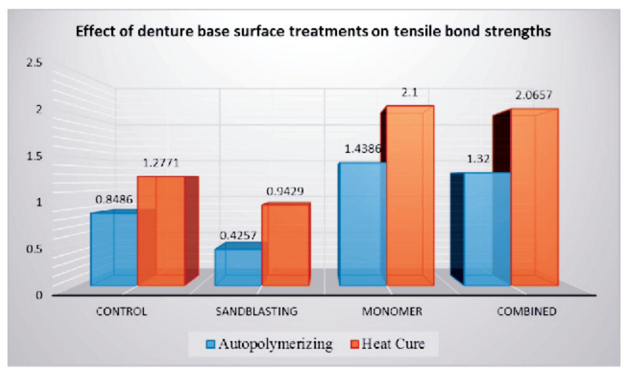

Figure 4

DISCUSSION:

Soft liner is an important material used for the fabrication of complete and partial prosthesis. The viscoelastic properties of the soft liners help in distribution of stress over the denture bearing tissues proving beneficial to the patients with resorbed ridges consisting of thin mucosa, bony undercuts, xerostomia and single dentures opposing the natural dentition. Unfortunately, the viscoelastic properties of the soft liners don't last more than years [12.] Plasticized acrylics and silicone rubber are the most commonly used materials. These materials are either auto or heat cured. Acrylic resin based gradually hardens because plasticizers usually leach out of the material. The plasticizers is responsible for maintaining the elasticity of the material. The silicone liner is more stable over time because it does not have the requisite of plasticizer as the polymer present within it act as an elastomer.[14]Prolong Elasticity and a favorable bond with the tissue surface of the denture are the two essential properties of a denture liner.[15] The three widely used testing methodology for evaluation of bonding strength between liners and denture basis are **Peel, Lap-Shear and Tensile Tests**.[16,17,18] American Society for Testing and Materials (ASTM) described the tensile test method to evaluate the bond between a soft liner and PMMA denture base.[19] This test update facts about the strength of the bond between the two surfaces along with the tensile strength of the material individually which is much beneficial to know the material's characteristics.

Pre-treated Sandblasted samples critically scaled down the tensile bond strength (Table II & III) when being compared with control group in both heat and auto-polymerizing soft liners. Apparently, the sandblasting technique helps in providing mechanical locks at the interactive sites thus, raising the surface area which helps in supporting a potent bond between two surfaces. But, the results after conducting the tests showed reduced bond strength after sandblasting treatment which may be due to the occurrence of stress at the junction of the two materials (PMMA and Soft Liner).

Statistically significant increase in tensile bond strength was seen with monomer treatment (Table II and III) in comparison to control group in both heat cured and auto polymerizing soft liners. By using monomer and adhesive in-together before applying soft liner, it helps in increasing the dissolution of the PMMA surface. This allows the fluid to go through the polymer chain and gets entrapped when infused monomer is vaporized which results in accelerated bond strength. Combined treatment noticeably increases the tensile bond strength (Table II and III) when compared with control group in both heat cured and autopolymerizing soft liners. In combined treatment, first sandblasting treatment was given followed by monomer treatment. Results showed that sandblasting reduced the tensile bond strength and monomer treatment increased the tensile bond strength. Therefore, in combined treatment, increase in tensile bond strength may be due to monomer treatment. Sandblasting treatment has no role in increase of tensile bond strength.

When both auto polymerized and heat cured group were compared with each other they demonstrated a significant difference in tensile bond strength. The tensile bond strength of heat cure group was significantly greater than autopolymerizing group in all subgroups.

It was found that mean bond strength for the control group of Mollosil was 0.84 Mpa which was less than mean bond strength for the control group of Molloplast-B i.e. 1.27Mpa. Khan et al[20] and Craig RG[11] documented at least 0.44 Mpa bond strength for elastic liners for the clinical use. Taking this criterion into an account both materials showed adequate bond strength to PMMA base resin.

The present study shows some limitations. The assessment of efficacy should be done for longer period of time to analyze the behavior of bond between denture liner and denture base resin (pretreated). This is in vitro study, so chances of simulation of oral condition is not possible to the desired level due to fluctuation of salivary P.H, salivary composition, difference in occlusion and usage of aids for dental maintenance. The test conditions might fail to reproduce the exact clinical conditions, as the testing samples consisted of two adhesive surfaces unlike clinical conditions which had a single adhesive surface. The above said factors are liable to be responsible for variation in bond strength.

The future scope of the present study is to evaluate the effectiveness of pretreatment of denture base surface on the degree of water sorption, co-efficient of thermal expansion and microscopic evaluation of behavior of bonding to liner. It is important to assess the physical properties of soft lining materials in clinical use and the effect of the oral environment on such properties. Because it is not possible to completely simulate clinical conditions and reproduce oral environment in the laboratory, so the final evaluation should be accomplished in a clinical situation.

Altering polymethyl methacrylate surfaces by sandblasting before the application of a resilient liner reduces the tensile bond strength. Therefore, mechanical surface preparation of denture base prior to silicone liner application might be unnecessary and disadvantageous. Pre-treatment executed using monomer before adhesive usage increased the tensile bond strength. So, clinically, it is recommended to go for chemical treatment of denture bases before liner application.

CONCLUSION:

Within the limitations of this study, following conclusions can be drawn:

- Heat cure silicone liner had higher tensile bond strength (< .001) than autopolymerizing silicone liner.
- Treating a denture base resin surface with monomer significantly increased the tensile bond strength of heat cure and autopolymerizing resilent liner.
- Sandblasting pretreatment of denture base resin decreased the tensile bond strength (< .001) of both silicone liners.
- Combined treatment (Sandblasting and Monomer) increased the tensile bond strength although difference was non-significant with monomer treatment subgroup.

REFERENCES:

1) Dootz ER, Koran A, Craig RG. Physical property comparison of 11 soft denture lining materials as a function of accelerated aging. J Prosthet Dent 19939:114-9.
2) Garcia RCM, Leon BLT, Oliveira VMB, Cury AA. Effect of a denture cleanser on weight, surface roughness, and tensile bond strength of two resilient liners. J Prosthet Dent 20039:489-94.
3) Kasugar Y, Akiba N, Minakuchi S. Basic evaluation on physical properties of experimental soft lining materials. Dent Materials J 20110(1):45-51.
4) Madan N, Datta K. Evaluation of tensile bond strength of heat cure and autopolymerizing silicone-based resilient denture liners before and after thermocycling. Indian J Dent Res 20123(1):64-8.
5) Ozkan YK, Sertgoz A, Gedik H. Effect of thermocycling on tensile bond strength of six silicone-based, resilient denture liners. J Prosthet Dent 20039:303-10.
6) Kulkarni RS, Parkhedkar R.he effect of denture base surface pretreatments on bond strengths of two long term resilient liners. J dv Prosthodont 2011(1):16–.
7) Aloul RK, Shen C. The influence of plasticizer loss on the viscoelasticity of temporary soft liners. J Prosthodont 20021(4):254-62.
8) Jacobsen NL, Mitchell DL, Johnson DL, Holt RA. Lased and sandblasted denture base surface preparations affecting resilient liner bonding. J Prosthet Dent 19978:153-8.
9) Sarac D, Sarac S, 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 20065:143-51.
10) El-Hadary A, Drummond JL. Comparitive study of water sorption, solubility, and tensile bond strength of 2 soft lining materials. J Prosthet Dent 200083:356-61.
11) Craig RG, Gibbons P. Properties of resilient denture liners. J Am Dent Assoc. 19613:382-390.
12) Kawano F, Dootz ER, Koran A, Craig RG. Bond strength of six soft denture liners processed against polymerized and unpolymerized poly (methyl methacrylate). Int J Prosthodont 19970:178-82.
13) Zarb, Bolender. Prosthodontic treatment for edentulous patients. 12th ed.Elsevier India Private Ltd 2004.p.198-202.
14) Machado AL, Breeding L, Aaron. Effect of microwave disinfection on the hardness and adhesion of two resilent liners. J Prosthet Dent 20054:183-9.
15) Mahajan N, Datta K. Comparison of bond strength of auto-polymerizing, heat cure soft denture liners with denture base resin- An In Vitro study. J Indian Prosthodont Soc 20100:31-5.
16) Al-Athel MS, Jagger RG. Effect of test method on the bond strength of a silicone resilient denture lining materal. J Prosthet Dent 19966:535-40.
17) Kutay O. Comparison of tensile and peel bond strengths of resilient liners. J Prosthet Dent 19941: 525-31.
18) McCabe JF, Carrick TE, Kanohara H. Adhesive bond strength and compliance for denture soft lining materials. Biomaterials 200223: 1347-52.
19) ASTM D 429-81. Standard test method for rubber property-adhesion to rigid substrates. Annual book of ASTM standards. West Consohocke, PA: ASTM998.
20) Khan Z, Martin J, Collard S. Adhesion characteristics of visible light-cured denture base material bonded to resilient lining materials. J Prosthet Dent. 19892:196–00.