ORIGINAL RESEARCH

A Comparative Study on Tensile Bond Strength of a Soft Room Temperature Vulcanized Silicone Relining Material to Poly (Methyl Methacrylate) Denture Base Resin after Different Surface Treatments - An *In Vitro* Study

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ABSTRACT

Background and Objectives: Soft denture liners act as a cushion for denture-bearing mucosa through absorption and redistribution of the masticatory forces. The most common problem encountered using soft denture liners is lack of interfacial bond strength. Weakened bond strength can result in the delamination of reline material from the denture base, both of which are structurally different in nature.

Materials and Methods: A total of 120 heat polymerizing acrylic resin blocks were fabricated with the help of a customized five piece brass mold. The study was divided into four different groups with following surface treatments of the bonding surface: Control group (no surface treatment), surface treatment with air abrasion, surface treatment with methyl methacrylate monomer, and surface treatment with dichloromethane. After surface treatment of the bonding surface of the acrylic blocks, the adjacent two blocks were joined with GC RELINE^{TM} SOFT reliner. All specimens were then tested for tensile bond strength on an Instron testing apparatus. The findings were statistically analyzed using one-way analysis of variance and Tukey's honest significance difference test.

Results: The tensile bond strength of the samples surface treated with methyl methacrylate monomer produced the strongest bond, followed by surface treatment with dichloromethane and then air abrasion surface treatment.

Conclusion: Surface treatment with methyl methacrylate monomer of the bonding surface improves the tensile bond strength of the reliner to denture base resin. The samples exhibit adhesive kind of failure between the silicone liner and heat-polymerized denture base resin when they were tested for the tensile load.

Keywords: Acrylic resin, Air abrasion, Denture base, Dichloromethane, Methyl methacrylate, Silicone liner

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INTRODUCTION

In an edentulous individual with a complete or a partial denture prosthesis, the masticatory load and functional stresses are transmitted to the bone through mucoperiosteum. These functional stresses lead to gradual changes of oral tissue resulting in loss of accurate adaptation of the denture to the underlying tissues. The condition of the bearing tissue may be adversely affected by high-stress concentrations during function which can lead to chronic soreness, pathologic changes, and bone loss. These problems can be solved by relining the intaglio surface of the denture with a soft denture liner. Soft denture liners play an important role in removable prosthodontics. Soft denture liners are often used for the management of painful or atrophied mucosa or traumatic ulceration associated with wearing dentures. The soft denture liner provides comfort for the patient and may reduce residual ridge resorption by reducing the impact force in the load-bearing areas of the supporting structures during function.[1-5] It is well known that the ability of a denture reline material to a denture base polymer depends on the propensity of the contents of reline material to penetrate the denture polymer and establish an interwoven polymer network. Different surface treatments by various workers have been done to improve the shear bond strength of denture reliners to poly(methyl methacrylate) denture base resin, of which some showed enhancement of bond strength-with conflicting results.[6]

The purpose of this study is to evaluate the effect of different surface treatments on the tensile bond strength between soft room temperature vulcanized silicone reliner and poly(methyl methacrylate) denture base resin.

MATERIALS AND METHODS

This study was done to evaluate the tensile bond strength of commercially available silicone-based soft denture reliner (GC RELINE^{TM} SOFT) to poly(methyl methacrylate) denture base resin ($^{®}$DPI HEAT CURE^{TM}) after different

surface treatments of the denture base by air abrasion, methyl methacrylate monomer, and dichloromethane.

The Methodology followed in this Study was

1. Preparation of heat polymerizing acrylic resin blocks using heat polymerizing.
   Acrylic resin (DPI Heat Cure™, Dental Products of India Ltd.).
2. Surface treatment of acrylic resin blocks:
   Following were the four sample groups with different surface treatments:
   - Group A: Control group with no surface treatment.
   - Group B: Surface treatment with air abrasion (50-µm aluminum oxide particles) for 30 s.
   - Group C: Surface treatment with methyl methacrylate monomer of DPI HEAT CURE™ for 180 s.
   - Group D: Surface treatment with dichloromethane for 30 s.
3. The adjacent surfaces of two 30 mm × 10 mm × 10 mm acrylic resin blocks were joined by GC RELINE™ SOFT reliner.
4. Tensile bond strength testing on Instron testing apparatus (model 4206, Instron Corp., Canton, Mass.).

RESULTS

A total of 60 specimens (four groups with 15 samples in each group) were prepared, and they were tested for tensile bond strength on an Instron testing apparatus. Reading in the Instron testing apparatus at the time of debonding between the reliner and heat-polymerized acrylic resin was noted. The tensile bond strength values obtained from various groups were tabulated and analyzed for statistical significance. The mean between four groups was compared using one-way analysis of variance (ANOVA) and the intercomparison between each group was done using Tukey's honest significance difference (HSD) test. The results were analyzed using software package SPSS "version 7.0."

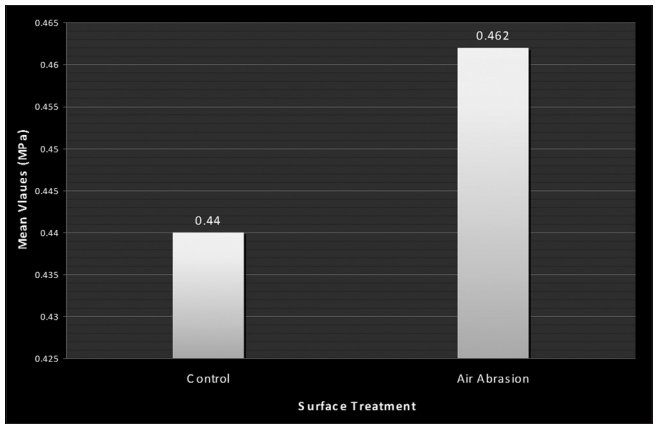
Table 1: One-way ANOVA used to analyze total data

Group	F	Significance (*P*)
Between surface treatment groups (A–D)	480.178	<0.001

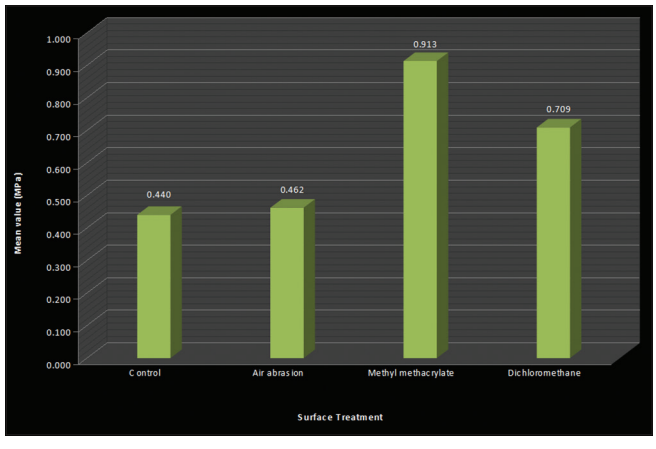
ANOVA: Analysis of variance

Table 1 shows one-way ANOVA used to analyze total data. An F = 480.178 and $P < 0.001$ was found which was very highly significant. Since difference observed is significant, we infer that there is difference in at least one of the groups.

Table 2 shows multiple comparisons, i.e., comparison within the groups, using Tukey's HSD test. The significance value between each group is analyzed. There was a non-significant increase between the groups "A" and "B" in tensile bond strength of the specimens with air abrasion surface treatment [Graph 1]. The tensile bond strength was greatest when the specimens were surface treated with methyl methacrylate followed by that with dichloromethane [Graph 2].



Graph 1: Comparison of mean tensile bond strength between control (a) and air abrasion (b) surface-treated samples



Graph 2: Comparison of mean tensile bond strengths after different surface treatments

Table 2: Descriptive statistics with mean and standard deviation of each group

(I) Group	(J) Group	Mean difference (I – J)	Significance (P)
Control	Air abrasion	−0.02200	0.431
	Methyl methacrylate	−0.47267	0.001 vhs
	Dichloromethane	−0.26867	0.001 vhs
Air abrasion	Methyl methacrylate	−0.45067	0.001 vhs
	Dichloromethane	−0.24667	0.001vhs
Methyl methacrylate	Dichloromethane	−0.20400	0.001 vhs

DISCUSSION

Gradual changes of oral tissues require that the complete or partial dentures be relined to improve their adaptation to the supporting tissue. Depending on their consistency, denture reliners can either be of hard or soft types. Kawano *et al*.[7] evaluated the cushioning effect of soft denture liners indicating that a soft liner reduced the impact force during function.

Loney *et al*.[8] found that increasing the thickness of reliner by more than 3 mm on the denture base resin greatly reduced the bond strength and other physical properties. Hence, in this study, a uniform thickness of 3 mm of reliner was used. The forces that the lining material is clinically exposed to are more closely related to shear and tear tests. However, the tensile tests were effective in evaluating the bond strength and in ranking the material. Al-Athel *et al*.[9] pointed out that tensile failure was not caused by tensile forces alone because some shear forces are also developed in the tensile test. This occurs because of the high Poisson's ratio of silicone lining materials, where a reduction occurs in the cross-sectional area of a lining material when it stretches after the application of a tensile load, whereas the bonded portion maintains a constant area.[10] There was a non-significant increase in tensile bond strength of the specimens with air abrasion surface treatment. Takahashi and Chai[5] have noted that the bond strength of silicone reliners to denture base depends on the surface irregularities present on the denture surface. He has advocated that more the surface area better will be adhesion between the chemically two different materials. The mean tensile bond strength of 0.9127 MPa was maximum of all the groups. Jagger *et al*.[4] in his study have shown that denture base monomers are polymerizable. The penetration of these materials into the denture base theoretically improves bonding by participation on polymerization. There was also a very high significant increase in the tensile bond strength of silicone-based relining material to heat-polymerized acrylic resin specimens when the bonding surface of these specimens was surface treated with dichloromethane. The mean tensile bond strength was 0.7087 MPa which was the second largest of all the groups. Takahashi and Chai[5] stated that non-polymerizable solvents such as dichloromethane function by dissolving and swelling the surface layer of the denture base resin. This process enhances the diffusion of polymers and promotes the formation of a more extensive interwoven polymer network.[11]

In this study as per manufacturer's instruction, the samples were primed with GC RELINE^{TM} PRIMER R which contained ethyl acetate. According to Arima *et al*.,[12] ethyl acetate itself acts as a surface chemical etchant which changes the surface morphology. The simultaneous use of dichloromethane and ethyl acetate containing primer might have created unwantedly more of surface irregularities which can affect the adhesion between reliner and denture base resin. This could be the reason for inferior bond strength of dichloromethane (0.7087 MPa) as compared to that of methyl methacrylate (0.9127 MPa).

CONCLUSION

Within the limits of the present study and on the basis of results obtained, it can be concluded that there is a non-significant increase in tensile bond strength of the specimens with air abrasion surface treatment. The tensile bond strength is greatest when the specimens are surface treated with methyl methacrylate monomer. There is a very high significant increase in tensile bond strength when the specimens are surface treated with dichloromethane. However, the mean tensile bond strength of this group was less as compared to that of specimens surface treated with methyl methacrylate monomer. The samples showed adhesive kind of failure between the silicone liner and heat-polymerized denture base resin when they were tested for the tensile load.

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