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Assessment of Tensile Bond Strength of Heat-Polymerized Acrylic Soft Liners with Various Surface Pre-Treatment of Denture Bases: An In Vitro Study

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ABSTRACT

Background: Soft denture liners protect the denture bearing mucosa by acting as a cushion that evenly distribute functional load, avoiding local stress concentrations and improving retention of dentures there by providing comfort to the patient. The aim of the present study was to assess the tensile bond strengths of heat-polymerized acrylic soft liners with various surface pre-treatment of denture bases.

Material and methods: A 192 cuboidal blocks of heat-polymerized acrylic resin were made which were equally divided into two groups i.e Permasoft (Group 1) and Acrasoft (Group 2). Each group was further subdivided into four subgroups based on surface pre-treatment of denture base which was named as: Control, chemical, mechanical, and mechanochemical. A 3-mm thick resilient denture liner was packed between two resin blocks. Then, each subgroup divided into two test groups (n = 6) for testing tensile bond strength (using universal testing machine) after 24 h and 30 days post-immersion in artificial saliva. One-way ANOVA and Tukey test were used for data analysis.

Results: The tests showed result that there was greater tensile bond strength for Acrasoft group compared to Permasoft at both 24 h and 1 month. Between the two time periods, it was more for 24 h group. Among all mechanical method was in superior tensile bond strength.

Conclusion: This study conclude that all the tested pre-treatment methods showed better tensile bond strength than control group and it was maximum for mechanical group.

Keywords: Permasoft, Acrasoft, mechanical method.

INTRODUCTION

Transmission of occlusal forces on the denture-bearing area by denture bases leads to considerable strain on the soft tissue. Hence, ill-fitting dentures lead to inflammation of underlying soft tissue.[1] In 1961, Chase introduced the use of materials designed to rehabilitate abused denture supporting tissues and to restore them to health.[2] Subsequently, with time introduction and use of different products designed to recondition denture-bearing tissues occurs. Their function is to spread the forces uniformly to underlying soft tissues and also act as "shock absorber" of the strain created during mastication.[3,4] The major drawbacks of the permanent soft liners are the lack of a durable bond

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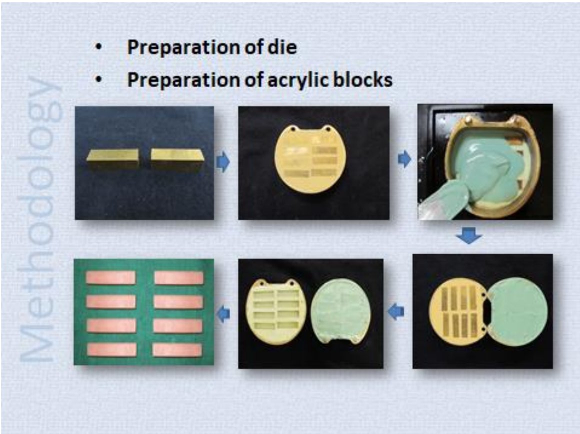
to denture base. Detachment of soft liners from the denture base is a common clinical occurrence. The bond strength of resilient liners depends upon the tensile strength of the materials. A reliable bond between denture base and soft liner is required for the denture to function properly.[5,6] The aim of the present study was to assess the tensile bond strengths ofheat-polymerized acrylic soft liners with various surface pre-treatment of denture bases.

MATERIAL AND METHODS

The present in vitro study was conducted to assess the tensile bond strength of heat-polymerized acrylic soft liners with various surface pre-treatment of denture bases. The materials used for the study were Trevalon (powder and liquid), Permasoft Soft liner, Acrasoft Soft liner, Lab putty, Type III Stone, MMA, Sand 250 µm, and Artificial saliva. Eight brass bars of uniform dimensions (40 mm × x10 mm x× 10 mm) were fabricated for preparing the mould for the acrylic blocks. A brass template was fabricated to orient and for providing 3 mm space for the soft liner.The brass dies were invested with lab putty inthe lower portion of the dental flask. After the puttywas set, the second pour was done with Type IIIgypsum and flasking was completed. After the finalset of the dental stone, the brass dies were regained. The heat-cured PMMA acrylic resin was mixedin a porcelain jar using stainless steel spatula bymaintaining the monomer: polymer ratio as 1:3 byvolume, following the manufacturer's instructions.The acrylic resin was packed in the mould in doughstage and kept under hydraulic bench press under2 kg static load for 10 m. After bench curing for1 h, the flask assembly was placed in acrylizer andthe temperature of water was raised from roomtemperature 24°C ± 1°C to 74°C and maintained for 2 h followed by 100°C for 1 h.[7]The flask assemblywas allowed to bench cool. The acrylic blocks wereretrieved and trimmed. 192 blocks were preparedfollowing the same procedure.The 192 blocks were divided into two groupsof 96 each and named as Group 1 (Permasoft)and Group 2 (Acrasoft). Each group was againsubdivided into A, B,C and D subgroups (24 each),depending on the type of surface treatment whichwould be performed.One face (10 mm ×x 10 mm) of each block waslabeled, and the opposite face was treated as follows:Subgroup A: No surface treatment, Subgroup B: Chemical treatment, Subgroup C: Mechanical treatment, and Subgroup D: Mechanochemicaltreatment.Chemical treatment was done by applying MMA with a cotton swab for 10 s. In mechanical treatment, the surface was sandblasted with 250 µmaluminum oxide at 0.06 mega pascals (MPa) pressure for 30.[8,9] In mechanochemicaltreatment, the surface was sandblasted with 250 µmaluminum oxide at 0.06 MPa pressure for 10s followed by the application of MMA with a cottonswab for 10 s. The acrylic blocks and the template wereoriented and invested in the lower half of the dental flask with lab putty. The surface treatedends of the blocks were kept facing each other.The second pour was done with type III gypsumand the flasking procedure was completed. Afterthe final set of gypsum, the template was removedand the mould was ready to be packed with softliner material. Group 1 blocks were packed withPermasoft material and group 2 blocks were packedwith Acrasoft material. The soft liner material was mixed in 1:4 ratio according to manufacturer's instructions, with a plastic spatula and packed into the mould, and placed in the hydraulicbench press for 15 m. Then, curing was done byplacing the flask assembly in acrylizer containing water at 95°C for 15 m. It was allowed to benchcool, and



the specimens were retrieved. The excessmaterial was cut with a sharp knife. A total of 96 specimens were prepared followingthe same procedure.

Table 1: The specimens were labeled and numbered as follows:

Surface treatment	Group I (24 h group)		Group II (1 month group)	
	Group 1 (Permasoft)	Group 2 (Acrasoft	Group 1 (Permasoft)	Group 2 (Acrasoft)
Control	A1 (1–6)	A2 (25–30)	A3 (49–54)	A4 (73–78)
Chemical	B1 (7–12)	B2 (31–36)	B3 (55–60)	B4 (79–84)
Mechanical	C1 (13–18)	C2 (37–42)	C3 (61–66)	C4 (85–90)
Mechanochemical	D1 (19–24)	D2 (43–48)	D3 (67–72)	D4 (91–96)

The specimens were immersed in distilled water for 24 h.[10]Half of the specimens from each subgroup were tested after 24 h. The remaining specimens were immersed in jars containing artificial saliva for 30 days. The artificial saliva was changed every 3 days to prevent fungal growth. Thermal cycling was done for these specimens to mimic the oral temperature conditions. The specimens were submitted to 3000 cycles, alternating with a 1-m dwell time between 5°C ± 1°C and 55°C ± 1°C.[11] The tensile bond strength was tested using aUniversal Testing Machine. The two ends of the specimen were held between the grips of the testing assembly, after which command was given to Universal Testing Machine with the help of personal computer that was attached to the machine. Tensile bond strength testing was performed at a crosshead speed of 5 mm/min with a gauge length of 5 cm. Bond strength was calculated as maximum load(N) divided by the cross-sectional area (mm^2) of the specimen and recorded in MPa as per the American Society for Testing and Materials (ASTM). Tensile bond strength = Load/Cross-sectional area. The same procedure was repeated for all the specimens. Tensile bond strength was calculated, and the results obtained were statistically analysed using SPSS software (Version 13, Chicago.2, USA) using one-way ANOVA. The means were compared using the Tukey (HSD) test. $P < 0.05$ was considered statistically significant, $P < 0.001$ was considered highly significant, and $P > 0.05$ was considered not significant.

RESULTS

The highest mean tensile bond strength was found in Acrasoft mechanically treated 24 h group, followed by Permasoft mechanically treated 24 h group and the least for Permasoft control 1-month group. Between the two soft liners tested, Group 2 (Acrasoft) showed more tensile bond strength than the Group 1 (Permasoft) for all the treatment groups at both time periods. Statistically, a highly significant difference was observed for mechanical and mechanochemical treatment groups ($P < 0.001$), and no statistically significant difference was observed between the chemical treatment groups ($P > 0.05$).

Fig 1: Specimen being tested.

Table 2: Intergroup comparison of chemical treatment subgroups at 24 hour and 1 month.

Time of testing	Mean ±SD		P
	Permasoft	Acrasoft	
24 Hr	B1 0.86±0.54	B2 0.89±0.14	1.000NS
1 month	B3 0.54±0.66	B4 0.58±0.16	1.000Ns

Table 3: Intergroup comparison of mechanical treatment subgroups at 24 hour and 1 month.

Time of testing	Mean ±SD		P
	Permasoft	Acrasoft	
24 Hr	C1 2.90±0.20	C2 4.01±0.24	<0.001
1 month	C3 1.7±0.32	C 4 2.72±0.04	<0.001

Table 4: Intergroup comparison of mechanomechanical treatment subgroups at 24 hour and 1 month.

Time of testing	Mean ±SD		P
	Permasoft	Acrasoft	
24 Hr	D1 2.04±0.20	D2 2.32±0.23	<0.01
1 month	D3 1.2±0.12	D4 1.72±0.14	<0.01

DISCUSSION

The effect of roughening the bonding surface by air particle abrasion[12,13] had higher bond strength compared with the smooth surface because of its irregularity which provides mechanical retention.[14] Pretreatment of denture base resin with monomer and acetone had shown to be effective in increasing the strength of repaired denture segments.[15]

Philip JM et al denture base surface pre-treatment can improve the adhesive tensile bond strength between the liner and denture base specimens. The results of this study infer that chemical, mechanical, and mechano-chemical pre-treatments will have different effects on the bond strength of the acrylic soft resilient liner to the denture base.[16] Mempally HK et al conuducted a study and resulted that tensile bond strength was greater for Acrasoft group compared to Permasoft at both 24 h and 1 month. Betweenthe two time periods, it was more for 24 h group. Among all methods, mechanical method resulted in superior tensilebond strength.[17]

Wieckiewicz et al. evaluated and compared tensile and shear bond strengths values of three modern autopolymerized silicone relining materials bonded to acrylic plates and found that all tested materials have acceptable adhesion values to acrylic resin.[18] Lau et al. conducted a study on soft and hard reliners and concluded that the tensile and shear bond strength values of denture soft reliners were significantly lower than denture hard reliners.[19]

CONCLUSION

The study concluded that tensile bond strength for Acrasoft group was greater compared to Permasoft at both 24 h and 1 month. Between the two time periods, it was more for 24 h group. Among all methods, mechanical method resulted in superior tensile bond strength.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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