British Journal of Pharmaceutical and Medical Research Vol.04, Issue 03, Pg.1900-1912, May-June 2019

Available Online at http://www.bjpmr.org

BRITISH JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

Cross Ref DOI : https://doi.org/10.24942/bjpmr.2019.511 Volume 04, Issue 03 May-June 2019

ISSN:2456-9836
ICV: 60.37

Research Article

Effect Of Denture Base Surface Pre-Treatments On Tensile Strength Of Two Different Soft Lining Materials After Immersion In An Artificial Salivary Medium- An In Vitro Study

Dr Jigar Sodha[1], Dr Rupal J. Shah[2], Dr Amisha Patel[1], Dr Sejal Mehta[1], Dr Dipika Sutariya[1], Dr Dhara Bajania[1]

[1]P.G. student, Dept Of Prosthodontics and Crown & Bridge, Govt. Dental College And Hospital, Ahmedabad, India.

[2]Professor& Head, Dept Of Prosthodontics and Crown & Bridge, Govt. Dental College And Hospital, Ahmedabad, India.

ARTICLE INFO

Article History:
Received on 10th May, 2019
Peer Reviewed on 18th May, 2019
Revised on 06th June, 2019
Published on 27th June, 2019

Keywords:
Soft-liners, tensile strength, Mollosil, Molloplast-B, artificial saliva

ABSTRACT

Statement of Problem: One of the most common problems observed in complete dentures is failure of adhesion of soft liners to denture base.

Purpose: The purpose of this study was to compare the effects of various surface treatments of denture base on tensile bond strength of two different soft lining materials after their immersion in an artificial salivary medium.

Materials and Methods: One hundred and twenty PMMA heat-cured acrylic resin blocks were fabricated each of dimensions 10mm x 10mm x 40mm for producing sixty PMMA specimens with soft liner in between two blocks. Samples were randomly divided into 3 groups; acid etching, sandblasting and control (no surface treatment) and two sub-groups for each group for two different soft lining materials i.e. Molloplast-B (Heat-cured soft lining material) and Mollosil (Self-cured soft lining material). One half of the samples in each sub-group was fabricated and immersed in artificial saliva for 7 days and the other half was fabricated on the same day of test conduction. To analyze the data, One-way ANOVA test was performed.

Results: There was significant difference in tensile bond strength for both the materials after different surface treatments and also after immersion in artificial saliva.

Conclusion: The tensile bond strength was significantly higher for Acid etched samples for each subgroup; Molloplast-B lined samples showed significantly higher tensile strengths for each surface treatment and immersion in artificial salivary solution showed decrease in tensile strengths for each sub-group.

Corresponding Author: Dr Jigar Sodha, *P.G. student, Dept Of Prosthodontics and Crown & Bridge, Govt. Dental College And Hospital, Ahmedabad, India*

INTRODUCTION:

Soft denture lining materials have been a focus of research and controversy in dentistry for more than a century, [1] with the earliest soft liners being natural rubbers. Today, soft lining materials include silicone elastomers and plasticized acrylic resins.

These liners are most commonly indicated in patients who are unable to tolerate the pressure transmitted by the prostheses because of thin mucosa or severe alveolar ridge resorption. Additional applications have emerged in the past few years viz. fabrication of obturators[2] and to modify transitional prostheses after stage I and II implant surgery.[3] Clinical experience suggests that in the presence of advanced residual ridge resorption and non-resilient mucosa, resilient denture liners may reduce the load on the supporting tissues and make dentures more comfortable for the patient.[4]

Lammie and Storer classified the processed resilient materials as follows:

1. Natural rubber
2. Polyvinylchloride
3. Polyvinylacetate
4. Methyl-methacrylate copolymer
5. Silicone.[5]

Adequate bonding between lining material and denture base material is important to avoid bond failure, which is one of the most serious problems with these materials. Bond failure creates a potential surface for bacterial growth and plaque or calculus formation.[6] Favorable properties of a denture liner becomes useless in the absence of a good bond to the denture base material.

Bond strength can be altered by various methods, namely mechanical roughening by metal, sand papering ,sandblasting, lasers, chemical treatments with Acetone, Methylene chloride, Methyl methacrylate, acid etching and mechano-chemical treatment. Adequate literature is available regarding mechanical surface roughening of denture bases. But, there is paucity of information about the chemical treatment particularly acid etching.[7,8]

During clinical use, soft lining materials are immersed in saliva and during denture storage they are soaked in water or an aqueous cleansing solution. Soft lining materials undergo two responses during immersion viz. leaching out of plasticizers and other soluble components and absorption of water or saliva.[9,10] Soft denture liners exhibit several problems associated with water absorption, leading to drastic changes in the structure and properties of the material such as loss of softness, distortion, surface deterioration, accumulation of plaque and debris, reduced bond strength and propensity for fungal/microbial accumulation and growth.[11,12]

The objective of this study is to explore and validate the impact of various surface treatments (sandblasting, acid etching and control) of denture bases on the tensile bond strength of different soft liners.

Materials and methods

A heat activated poly methyl methacrylate (PMMA) resin (Acralyn H, India); and two resilient liners, Mollosil (Detax GmbH & Co.KG, Germany) and Molloplast-B (Detax GmbH & Co KG, Germany), were used in this study. Molloplast-B is a Heat polymerized silicone based resilient liner whereas Mollosil is an auto - polymerized silicone based liner.

Sample consists of resilient liner of 3 mm thickness lined in between two blocks of acrylic resin. The acrylic resin blocks are of 10×10 mm cross section and 40 mm length. The dimension of specimen was such that they could be produced in conventional denture flasks and gripped easily in the Universal Testing Machine.

To standardize fabrication of specimens, a machine cut stainless steel master die was prepared and utilized to fabricate a rubber base mold. The dimensions of master die were 10×10×40mm. Four machine cut stainless steel spacers of 10×10×3mm dimensions were prepared (Figure 1).

Molds were prepared by investing the stainless steel master die in rubber base impression material. Wax patterns of the master die was fabricated by pouring molten wax into the rubber base mold. These wax patterns were then invested in the denture flasks and heat-cured PMMA resin blocks were fabricated according to manufactures' instructions (Figure 2). One hundred twenty such blocks were fabricated to prepare 60 specimens with soft liner in between two blocks.

Samples were randomly divided into 3 groups, each group containing 40 blocks (to fabricate 20 test specimens per group), which were followed by their surface treatment as follows:

GROUP A- 35% Hydrochloric acid etching (acid etching group). Samples were swabbed with 35% Hydrochloric acid for 30 seconds, washed with an air/water spray for 30 seconds, each surface dried for 20 seconds with an air spray (Figure 3).

GROUP S- Sandblasting with 110- µm Al_2O_3 particles with the nozzle measuring about 1.0 mm in diameter was held in light contact with each specimen, for 30 seconds at a pressure of 0.62 MPa (Figure 4).

GROUP C- No surface treatment (Control Group) . The non treated surface of the acrylic blocks (120) were marked using marker.

Each surface-treated group was divided into two subgroups. Each subgroup containing 10 specimens and was labeled as subgroup 1 and subgroup 2. Subgroup 1 was lined by heat-polymerized silicone based resilient liner - Molloplast B (Figure 5). Subgroup 2 was lined by auto-polymerized silicone-based resilient liner – Mollosil (Figure 6). Half of the samples in each subgroup were immersed in artificial saliva and stored for 7 days (Figure 7). The samples were then subjected to tensile stress in Universal testing machine (Instron-3369,Massachusetts, United States) at a crosshead speed of 5mm/min until failure. The maximum tensile stress before failure was recorded for each specimen, and the failure force was recorded in newtons (N). The following equation was used to calculate the tensile bond strength: TS= F/D, where TS is the tensile strength (MPa), F is the force (N), and D is the adhesion surface area (mm^2).

The results obtained were statistically analyzed by ONE-WAY ANOVA to compare the effects of various surface treatments on both the soft-lining materials between and within the groups.

Figure 1: Stainless steel master die [10×10×40 mm] and spacers [10×10×3 mm].

Figure 2: Fabrication of heat-cured PMMA blocks

Figure 3: Surface pre-treatments with 35% hydrochloric acid etching

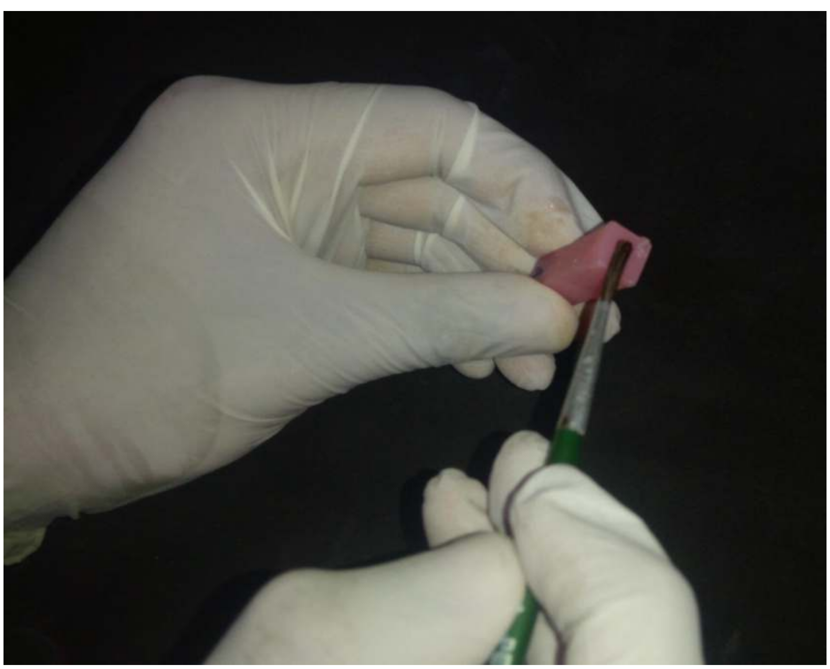


Figure 4: Surface pre-treatments with 110 μm Al_2O_3 air abrasion

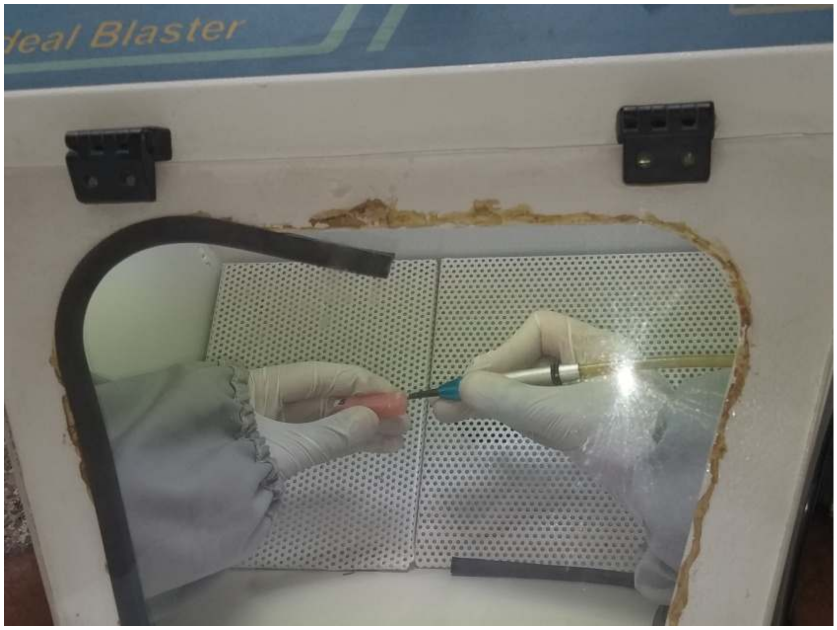


Figure 5: Fabrication of test specimens for Molloplast-B subgroups

Figure 6: Fabrication of test specimens for Mollosil subgroups

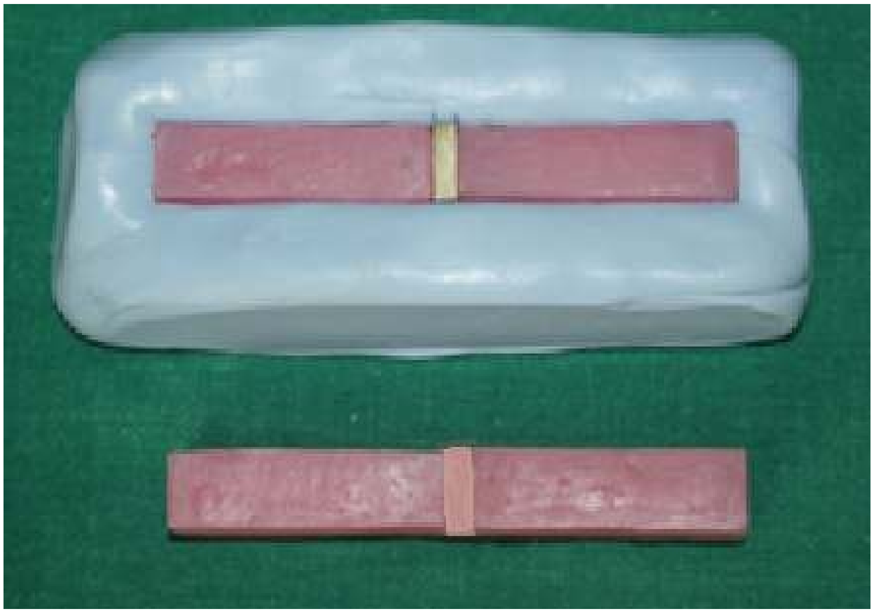
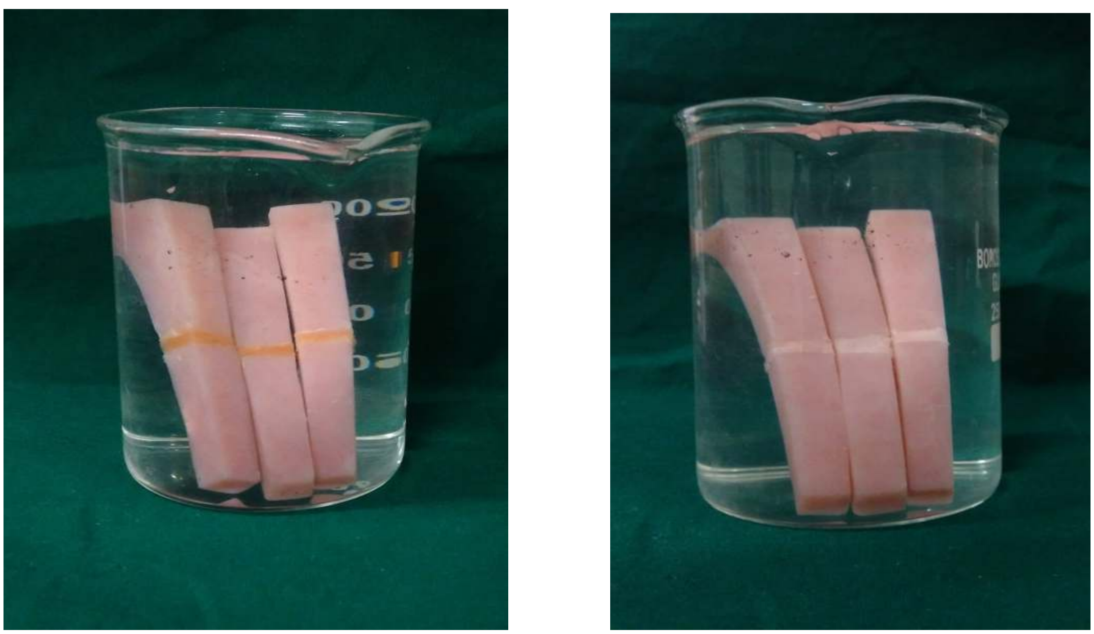


Figure 7: Test specimens immersed in artificial saliva for 7 days



RESULTS

Significant differences ($p < 0.05$) were obtained among samples for different surface treatments and their immersion in artificial saliva for both the soft lining materials.

The mean values and standard deviation for various surface treatments for Molloplast-B and Mollosil are depicted in Table 1 and graphically plotted in Graphs 1 to 5. The tensile strength values ranged from 0.77 (±0.07) MPa to 1.32 (±0.09)MPa for Molloplast-B samples for various surface treatments with significant differences ($p<0.05$) within the Molloplast-B group. Also the values of tensile strength varied from 0.47 (±0.05)MPa to 0.81 (±.05)MPa for Mollosil Group.

Table 1 showing Mean(±SD) tensile strength values (MPa) for Molloplast-B and Mollosil soft lining materials for various surface treatments

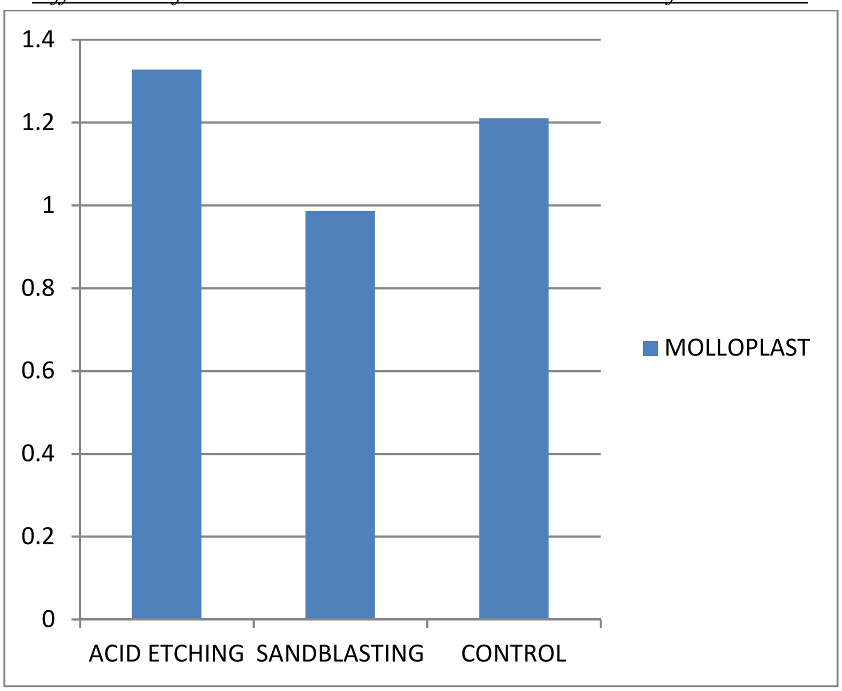
Surface treatments	Molloplas-B	Mollosil
Acid etching without immersion in artificial saliva (AX)	1.32 (±0.09)	0.81 (±.05)
Acid etching with immersion in artificial saliva (AY)	1.09 (±0.08)	0.67 (±0.04)
Sandblasting without immersion in artificial saliva (SX)	0.98 (±0.09)	0.67 (±0.05)
Sandblasting with immersion in artificial saliva (SY)	0.77 (±0.07)	0.47 (±0.05)
Control without immersion in artificial saliva (CX)	1.21 (±0.07)	0.72 (±0.04)
Control with immersion in artificial saliva (CY)	0.99 (±0.07)	0.54 (±0.04)

In general, the specimens treated with Acid etching showed the highest tensile strength for both the Molloplast-B and Mollosil groups while sandblasted groups showed the least tensile strengths for each soft-lining material. Also artificial salivary immersion showed significantly reduced tensile strengths ($p<0.05$) for each sub-groups.

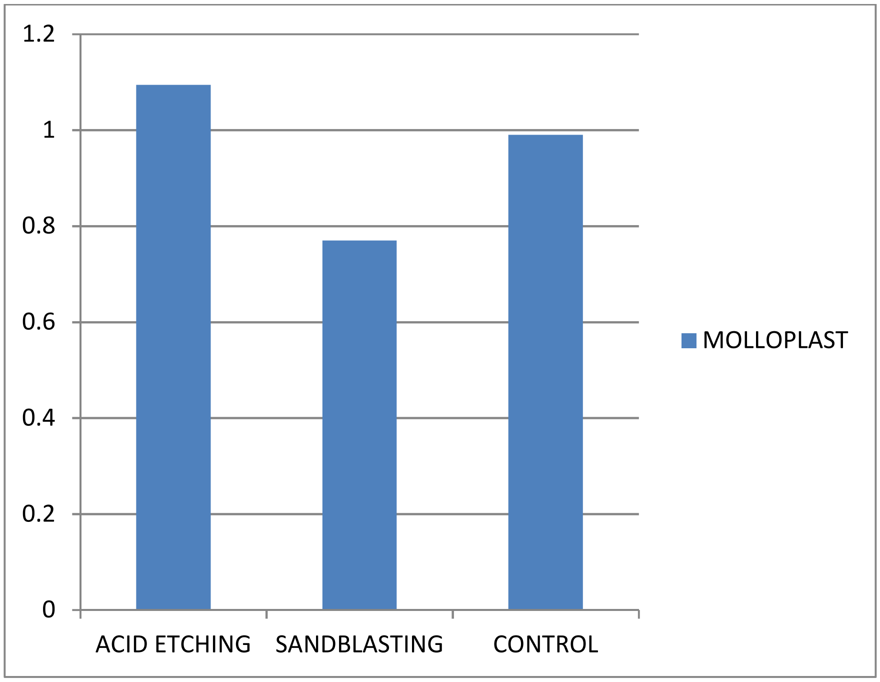
The type of failure predominantly for Molloplast-B samples was mixed type while for Mollosil samples it was of adhesive type predominantly

.

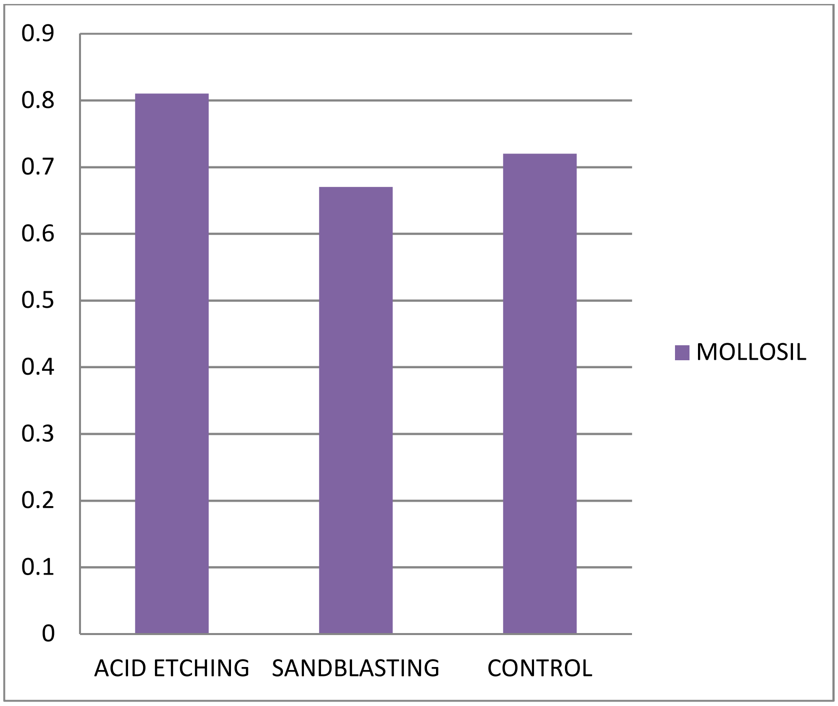
Graph 1: comparison of tensile bond strength (MPa) of test specimens for molloplast-b lining material after different surface treatments without immersion in artificial saliva



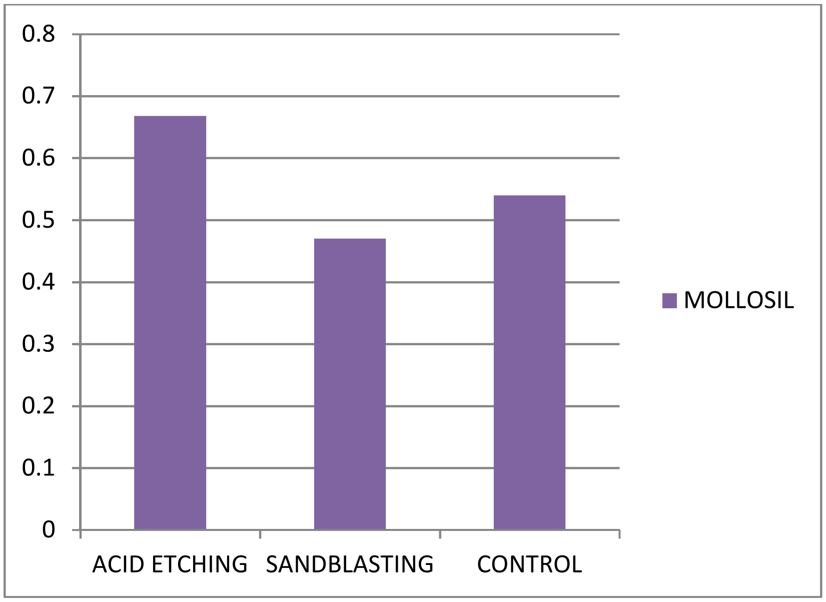
Graph 2: comparison of tensile bond strength(MPa) of test specimens for molloplast-b lining material after different surface treatments after immersion in artificial saliva for 7 days.



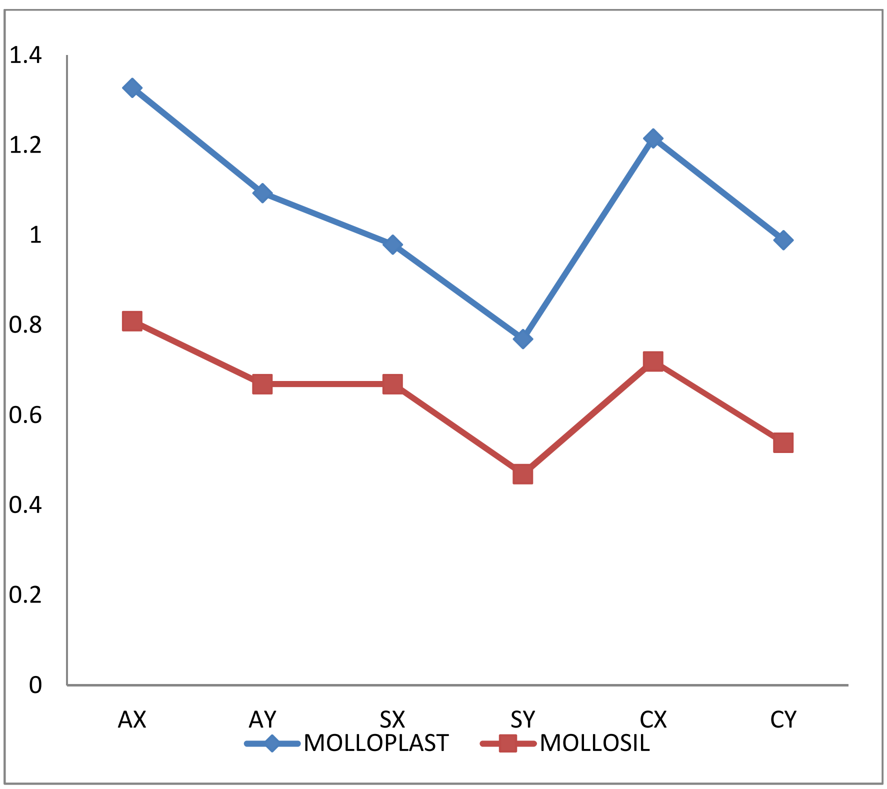
Graph 3: comparison of tensile bond strength (MPa) of test specimens for mollosil lining material after different surface treatments without immersion in artificial saliva



Graph 4: comparison of tensile bond strength(MPa) of test specimens for mollosil lining material after different surface treatments after immersion in artificial saliva for 7 days



Graph 5: comparison of tensile bond strength(MPa) of test specimens between molloplast-b and mollosil for all the subgroups in line diagram



DISCUSSION

In service, debonding of the soft denture lining materials is a common occurrence. The bond strength of soft denture liners to PMMA denture base resins is weak, and when the separation takes place the localized area may become unhygienic and nonfunctional. Ideally, the soft denture liners should bond sufficiently well to PMMA denture base resin to avoid failure of the interface during the service life of the prosthesis.

Numerous materials have been used as resilient liners since the introduction of velum rubber. These include Acrylic based liners and Silicone based liners, any have been used with varying levels of success, but limitations exist in the areas of cleansability, hardness, volumetric change due to water absorption, and abrasion resistance.[7] One problem is the **adhesive failure** that occurs between the liner and the denture base. The importance of the bond strength was recognized when **Wright[13]** concluded that the most common reason for failure of a soft-lined denture was the failure of "adhesion" between the liner and denture base. Therefore this study was undertaken to estimate the bond strength of different soft liners to PMMA resin.

Due to similar chemical structure **Acrylic based liners** bond **chemically** to the PMMA denture base however, an **adhesive primer** is supplied to aid in bonding to denture base resin because **silicone soft liners** have little or no chemical adhesion to PMMA denture base resin. Adhesive is MMA / EMA based and act as a solvent that dissolves the PMMA surface. These bonding agents interact with the surface layer of the denture base polymer and the soft liner.

Tensile bond strength values are **highest for acid etching group and least for sandblasting group**. These findings are in accordance with the studies by **Amin et al [14] and Gundogdu (2014)[15]** whereby they reported that roughening the acrylic resin base with air-borne particle abrasion before applying the resilient lining material **weakened the bond.** They proposed that the lower bond strengths were due to stresses that occurred at the interface of the PMMA/resilient liner junction or that the size of the irregularities created by airborne-particle abrasion medium might not be sufficient to allow the resilient lining material to flow into it. However, **Craig and Gibbons[8]** reported that a roughened surface **enhanced the bond strength** and that the adhesive values obtained with a roughened surface were approximately double that of a smooth surface.

In the present investigation, abrasion pretreatment using 110-µm Al_2O_3 significantly decreased the Tensile Bond Strength for both the soft liners.

Surface treatments produce irregularities in the polymethyl methacrylate (PMMA) that can facilitate mechanical locking of the resilient lining material, thereby improving the bond strength between the denture base and the resilient lining material.[3] The **mechanical surface treatment theoretically increases the surface area** and mechanical locks which should benefit the bonding and result in stronger bonds. However, surfaces which have **pits, fissures, and discontinuities with sharp corners** create points for the development of stress concentration and may also cause the entrapment of air or gases that result in voids in the bond interface, leading to reduction of bond strength between the two materials.[3,14]

Jacobsen et al[7].have considered the ability of soft lining material to penetrate into the irregularities of the PMMA. The penetration coefficient for liquids into a space is given by:

Penetration coefficient (PC) = $\gamma\cos\theta/2\eta$

Where γ = surface tension,
θ = contact angle,
η = viscosity.

If this logic is applied to penetration of liners into the irregularities produced by air abrasion, increasing the viscosity of resilient liners for a given contact angle and surface tension reduces the penetration of the liner. This could explain the lower tensile strengths of sandblasted specimens observed in this study.

The surface treatment of denture base by **acid etching** enhanced bond strength of both the liners. For Molloplast-B and Mollosil, the results were statistically significant. Silicone based liners, require an adhesive MMA/EMA, a solvent that dissolves the PMMA surface, and the bond strength of silicone liners will depend on tensile strength of the material and the adhesive used. Therefore, using acid etching and adhesive together prior to the resilient liner application may effectively increase the dissolution of the PMMA surface.[16]

The effects of artificial saliva were compared by the ONE-WAY ANOVA TEST for Molloplast-B and Mollosil samples respectively. It suggests that there is a **significant difference (p< 0.05)** in tensile strengths after immersion in artificial saliva. Similar results were obtained in the studies conducted by **Sinobad et al, Amin et al[14]** where bond strength **decreased** on immersion in water. These results are in stark **contrast** with the findings of study done by **Dootz et al (1993),[17] and Craig and Gibbons,[8] Jacob Philip (2012)[18]** who reported that tensile strength of resilient lining materials **increased after storage in water,** while according to one of the studies by **El- Hadary (2000)[15] no significant change** was noted on tensile strength after immersion in water.

The lower bond strength may result from the swelling and stress formation at the bond interface, or from a change in the viscoelastic properties of the liner, rendering the material stiffer and better able to transmit external loads to the bond site. Water sorption by lining material leads to change in dimension and stress concentration at liner-denture base interface reducing the bond strength.[19] Filler type and its bonding to the polymer is responsible for water absorption seen in auto polymerized silicone. Heat cured silicone has better bond to filler and greater cross linking leading to the production of a denser material which are devoid of micro pockets of water within the material.[20] The residual cross linking agent within the material also contributes to absorption of water.

Fillers such as silica can be the reason for high water absorption in soft lining materials.[19] Silane treated silica when used as fillers showed less water sorption. Higher cross linking shows lower tear since it reduces segmental mobility of polymeric chains. Higher filler concentration, their grade and a strong bond between filler and polymer also increases tear strength.[21] Application of a sealer as a mechanical barrier can reduce water sorption. Decreased number of hydrocarbon groups within polymer leads to increased hydrophilicity.[16]

The comparisons for various surface treatments between Molloplast-B and Mollosil shows that the tensile bond strengths for **Molloplast-B** samples were **significantly higher** for each group as compared to **Mollosil.** These findings co-relate with the studies by **Jepson et al,[21] Kawano et al(1992)[22], Ayse Mese(2008)[9]** that heat polymerized silicone-based resilient lining materials were more successful than soft lining materials containing plasticizer. Both the soft lining materials have sufficient bond strength to denture base resin materials, but heat-polymerized silicone based resilient lining materials have more bond strength than that of auto polymerized silicone based resilient lining materials.[24]

Craig and Gibbons[8] assessed the Tensile Bond Strength (TBS) of resilient lining materials and claimed that 0.45 MPa is an adequate adhesive value for an optimal bond. According to Kawano et al[23] a bond strength of 0.44 MPa is acceptable for the clinical use of resilient lining materials**.** **Khan *et al*.** reported that soft denture liners should have a minimum of 0.44 MPa (4.4 kg/cm^2) bond strength to be acceptable for clinical use. Considering the above mentioned criteria, the results of the present investigation indicates that both the soft lining materials used in this study have got satisfactory bond strength for clinical application.

SUMMARY AND CONCLUSION

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

i. The tensile bond strength of **Molloplast-B (heat-cured soft liner)** was significantly **higher** than **Mollosil (self-cured soft liner),** after various surface treatments of PMMA.

ii. The tensile strength of both the soft lining materials after various surface treatments was in the following order:
Acid etching (Chemical) > Control > Sandblasting (Mechanical)

iii. The tensile bond strength of both the materials significantly **reduced** after immersion in an **artificial salivary medium**.

BIBLIOGRAPHY

1. Mack PJ. Denture soft linings: materials available. Aust Dent J. 1989;34(6):517–21.
2. Russell EA. Management of a mucoepidermoid carcinoma of the palate. Report of a case. Oral Surgery, Oral Med Oral Pathol. 1976;41(4):436–40.
3. Schwartz-Arad D, Chaushu G. Placement of Implants Into Fresh Extraction Sites: 4 to 7 Years Retrospective Evaluation of 95 Immediate Implants. J Periodontol. 1997;68(11):1110–6.
4. Kawano F, Koran A, Asaoka K, Matsumoto N. Effect of soft denture liner on stress distribution in supporting structures under a denture. Int J Prosthodont. 6(1): 43-9.
5. Lammie GA, Storer R. A preliminary report on resilient denture plastics. J Prosthet Dent. 1958;8(3):411–24.
6. Kawano F, Dootz ER, Koran A, Craig RG. Comparison of bond strength of six soft denture liners to denture base resin. J Prosthet Dent. 1992;68(2):368–71.
7. Jacobsen NL, Mitchell DL, Johnson DL, Holt RA. Lased and sandblasted denture base surface preparations affecting resilient liner bonding. J Prosthet Dent. 1997;78(2):153–8.
8. Craig RG, Gibbons P. Properties of resilient denture liners. J Am Dent Assoc. 1961;63(3):382–90.
9. Mese A, Guzel KG. Effect of storage duration on the hardness and tensile bond strength of silicone- and acrylic resin-based resilient denture liners to a processed denture base acrylic resin. J Prosthet Dent. 2008;99(2):153–9.
10. Murata H, Kawamura M, Hamada T, Saleh S, Kresnoadi U, Toki K. Dimensional stability and weight changes of tissue conditioners. Journal of oral rehabilitation. 2001 Oct;28(10):918-23.
11. El-Hadary A, Drummond JL. Comparative study of water sorption, solubility, and tensile bond strength of two soft lining materials. J Prosthet Dent. 2000;83(3):356–61.
12. Kazanji MN, Watkinson AC. Influence of thickness, boxing, and storage on the softness of resilient denture lining materials. J Prosthet Dent. 1988 Jun; 59(6):677-80.
13. Wright PS. Characterization of the Adhesion of Soft Lining Materials to Poly (methyl methacrylate). J Dent Res. 1982;61(8):1002–5.
14. Amin WM. Amin W.M, Fletcher A.M, Ritchie G.M. The nature of the interface between polymethyl methacrylate denture base materials and soft lining materials. J Dent. 1981;9(4):336–46.
15. Gundogdu M, Yesil Duymus Z, Alkurt M. Effect of surface treatments on the bond strength of soft denture lining materials to an acrylic resin denture base. J Prosthet Dent. 2014 Oct; 112(4):964-71.
16. Philip JM, Ganpathy DM, Ariga P. Comparative evaluation of tensile bond strength of a polyvinyl acetate-based resilient liner following various denture base surface pre-treatment mrthods and immersion in artificial salivary medium: An in vitro study. Contemp Clin Dent 2012;3:298-301.
17. Dootz ER, Koran A, Craig RG. Physical property comparison of 11 soft denture lining materials as a function of accelerated aging. J Prosthet Dent. 1993;69(1):114–9.
18. Philip JM, Ganpathy DM, Ariga P. Comparative evaluation of tensile bond strength of a polyvinyl acetate-based resilient liner following various denture base surface pre-treatment mrthods and immersion in artificial salivary medium: An in vitro study. Contemp Clin Dent 2012;3:298-301.
19. Oğuz S, Mutlay MM, Doğan OM, Bek B. Color change evaluation of denture soft lining

materials in coffee and tea. Dent Mater J. 2007;26(2):209–16.

20. Hayakawa I, Akiba N, Keh E, Kasuga Y. Physical properties of a new denture lining material containing a fluoroalkyl methacrylate polymer. J Prosthet Dent. 2006 Jul; 96(1):53-8.
21. Jepson NJA, McCabe JF, Storer R. Age changes in the viscoelasticity of permanent soft lining materials. J Dent. 1993;21(3):171–8.
22. Kawano F, Dootz ER, Koran A CR. Bond strength of six soft denture liners processed against polymerized and un-polymerized poly methyl methacrylate. Int J Prosthodont. 1997; 10: 178-82.

How To Cite This Article:

Jigar Sodha, Rupal J. Shah, Amisha Patel, Sejal Mehta, Dipika Sutariya, Dhara Bajania ***Effect Of Denture Base Surface Pre-Treatments On Tensile Strength Of Two Different Soft Lining Materials After Immersion In An Artificial Salivary Medium- An In Vitro Study*** **Br J Pharm Med Res , Vol.04, Issue 03, Pg.1900-1912, May - June 2019. ISSN:2456-9836**

Cross Ref DOI : https://doi.org/10.24942/bjpmr.2019.511

Source of Support: Nil | **Conflict of Interest:** None declared