ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 7, Issue – 4, August – 2024, Page No. : 114 - 119

Comparison of Tensile Bond Strength of Soft Denture Liner Material on Denture Bases Fabricated By Compression Molding, Injection Molding and Milled Cad - Cam Technique - An Invitro Study

[1]Dr. Anshul Singh, Post Graduate, Department of Prosthodontics and Crown and Bridge, Vokkalighara Sangha Dental College and Hospital, Bengaluru. India.

[2]Dr. Surendra Kumar G. P., Professor, Department of Prosthodontics and Crown and Bridge, Vokkalighara Sangha Dental College and Hospital, Bengaluru. India.

[3]Dr. Nalinakshamma M., Reader, Department of Prosthodontics and Crown and Bridge, Vokkalighara Sangha Dental College and Hospital, Bengaluru. India.

[4]Smt. Savitha P. Rao, Senior Lecturer, Department of Prosthodontics and Crown and Bridge, Vokkalighara Sangha Dental College and Hospital, Bengaluru. India.

Corresponding Author: Dr. Anshul Singh, Post Graduate, Department of Prosthodontics and Crown and Bridge, Vokkalighara Sangha Dental College and Hospital, Bengaluru. India.

Citation of this Article: Dr. Anshul Singh, Dr. Surendra Kumar G. P., Dr. Nalinakshamma M., Smt. Savitha P. Rao, "Comparison of Tensile Bond Strength of Soft Denture Liner Material on Denture Bases Fabricated By Compression Molding, Injection Molding and Milled Cad - Cam Technique - An Invitro Study", IJDSIR- August – 2024, Volume –7, Issue - 4, P. No. 114 – 119.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: In various clinical conditions like xerostomia, atrophic ridges and bony undercuts, resilient lining material may be desired for dentures. The bond strength amid the denture reline material and the denture base is critical. Various surface treatment methods have been attempted to improve the bond strength of resilient lining materials to the acrylic resin denture base.

Aim: To compare the tensile bond strength of soft denture liner material on denture bases fabricated by compression molding, injection molding and milled CAD - CAM technique following surface treatment with 36 % phosphoric acid.

Methods: 120 cuboidal blocks were prepared from PMMA using compression molding, injection molding and milled CAD-CAM technique. All blocks were surface treated with 36% phosphoric acid. 60 specimens were prepared by processing the denture liner material Molloplast B against the two opposing denture base resin blocks. All specimens were placed in artificial saliva for 24 hours before testing. Denture specimens were placed under tension and were pulled apart until failure in a universal testing machine

Results: The mean tensile bond strength of Group 1 was (0.74 ± 0.154). The mean tensile bond strength of Group 2 was (2.29 ± 0. 247). The mean tensile bond strength of Group 3 was (4.48 ± 0.289).

Conclusion: The tensile bond strength was highest between milled CAD-CAM denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid, followed by mean tensile bond strength between injection molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid. The mean bond strength between compression molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid was found to be least.

Keywords: Tensile Bond Strength, CAD-CAM, Molloplast, Phosphoric acid.

Introduction

Patients who are completely edentulous can be rehabilitated with implants or traditional complete dentures to restore their normal functioning. Resilient lining material may be recommended in a variety of clinical situations, including xerostomia, atrophic or resorbed ridges, dentures in opposition to natural dentition, and bony undercuts.[3]

These resilient materials reduce localized pressure to the underlying basal seat, redistributes functional and non-functional stresses steadily, and partly absorbs force. They have also advanced into a crucial curative tool for matured patients who have acute clenching and bruxing behaviors that have caused remarkable tissue damage in the form of pathologic alterations, persistent discomfort, and bone loss. They are also used to adjust transitional prosthesis succeeding implant surgery and in patients with oral cancer who have postoperative defects that need to be sealed.[3]

Silicone-based resilient liner materials are alike in composition to silicone-type impression materials, as they are dimethylsiloxane polymers. No plasticizer is mandatory to generate a softening effect with this material.[4] Dentures relined with silicones can only be effective if a satisfactory bond exists with denture base acrylic resin.[3]

In usage, resilient liners are frequently bathed in saliva, when outside of mouth, they are normally kept in either denture cleansers or water. In these conditions, water or saliva imbibes into the material, and plasticizers of the soft liner leach. When the material enlarged, stress increases between the bonding surfaces and the visco-elastic properties of resilient denture modifies. Moist environment of the oral cavity may affect the bonding of the soft liner to the denture base.[3]

In order to avert the disassociation of the denture reline from the base, a authentic adhesive bond is essential between these two surfaces, and this bond can be modified by the denture base material itself.[1] Untill recently, heat-activated poly-methyl methacrylate (PMMA) resins were the leading denture base material, fabricated by compression molding or injection molding. However, heat-activated PMMA resin has a volumetric shrinkage of roughly 7%.[1]

Computer-aided design and computer-aided manufacture (CAD-CAM) denture bases can be created by the subtractive approach or by milling.[1] Milled CAD-CAM denture bases have low volumetric deviation, as the denture base is milled from a disk of prepolymerized acrylic resin, circumventing further polymerization shrinkage.[1]

The bond strength amid the denture reline material and the denture base is pivotal because a delicate bond causes bacterial accretion, staining, jeopardized oral hygiene, and eventual separation of the reline material.

Factors that can lead to bond failure of denture reline materials include the chemical composition of the materials, liner thickness, nature of the adhesive, tear strength, and thermal stresses.[1]

Various surface treatment procedures have been attempted to improve the bond strength of resilient lining materials to the acrylic resin denture base. Etching with 36% phosphoric acid before applying the resilient lining materials enhances the union between the acrylic resin denture base and the resilient lining material.[2]

Studies have been done to evaluate the bond strength of soft liner to different types of PMMA independently. No comparative studies have been performed to evaluate the effect of acid surface treatment on the tensile bond strength of resilient lining material to the acrylic resin denture base fabricated by different methods.

Hence this study aims to evaluate the effect of bonding between soft liner and PMMA fabricated by different methods following acid etching.

Aim

To compare the tensile bond strength of soft denture liner material on denture bases fabricated by compression molding, injection molding and milled CAD - CAM technique following surface treatment with 36 % phosphoric acid.

Methodology

Samples preparation

- Forty 20*10*10 mm wax blocks were prepared, dewaxed and invested by compression molding technique.
- Forty 20*10*10 mm wax blocks were prepared, dewaxed and invested by injection molding technique.
- Forty 20*10*10 mm denture base resin blocks were fabricated by milled CAD-CAM technique.

Sample distribution (n=60)

GROUP 1 (n=20) samples (control group): A total of twenty samples were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through compression molding technique and surface treated with 36 % phosphoric acid.

GROUP 2 (n=20) samples :A total of twenty samples were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through injection molded technique and surface treated with 36% phosphoric acid.

GROUP 3 (n=20) samples :A total of twenty samples were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through milling and surface treated with 36 % phosphoric acid.

Following polymerization, the injection and compression molding samples were removed from the flask, trimmed, and PMMA disks were milled to create samples. Every sample from the three groups was etched for 30 seconds using 36% phosphoric acid (DeTrey Conditioner 36). After that, each surface was dried for 20 seconds using an air spray and cleaned under pressure with water and air for 30 seconds. The same resin was invested horizontally into two blocks in a metal flask, with baseplate wax sandwiched in between. To dewax the spacer, the flasks were placed in boiling water for five minutes. Hot water was used to clean the mold. The Molloplast-B Primo adhesive was applied with a brush on the bonding surface of acrylic resin blocks and air dried, then soft liner was packed into the space created by dewaxing, the flasks were closed, bench pressed for 4 min. The space created by dewaxing was filled by the resilient liner. The flash were removed and the final samples were polymerized in boiling water at 100 °C for approx. 2 hour, followed by bench cooling. Following polymerization excess soft liner was removed using B P blade.

The final test samples consisted of two blocks of resin with soft liner in between. All samples were kept in artificial saliva for 24 hours before testing. Denture samples were put under tension and were pulled apart until failure in a universal testing machine at a crosshead speed of 5 mm/min. Maximum tensile stress values before failure was noted in newtons (N).The tensile bond strength values (in MPa) was calculated as the maximum load (N) divided by the cross-sectional area of the interface (mm^2). The cross-sectional area (10×10 mm) will be 100 mm^2 for all denture base samples.

Results

Data was subjected to Normalcy test (Shapiro Wilk test). Data showed normal distribution. Hence parametric tests (ANOVA with Post-hoc Bonferroni) was applied.

The Shapiro–Wilk test is more appropriate method for small sample sizes (<50 samples) although it can also be handling on larger sample size while Kolmogorov–Smirnov test is used for n ≥50. For both of the above tests, null hypothesis states that data are taken from normal distributed population. If the p value of the Shapiro-Wilk Test is greater than 0.05, the data is normal. If it is below 0.05, the data significantly deviate from a normal distribution.

Tests of Normality

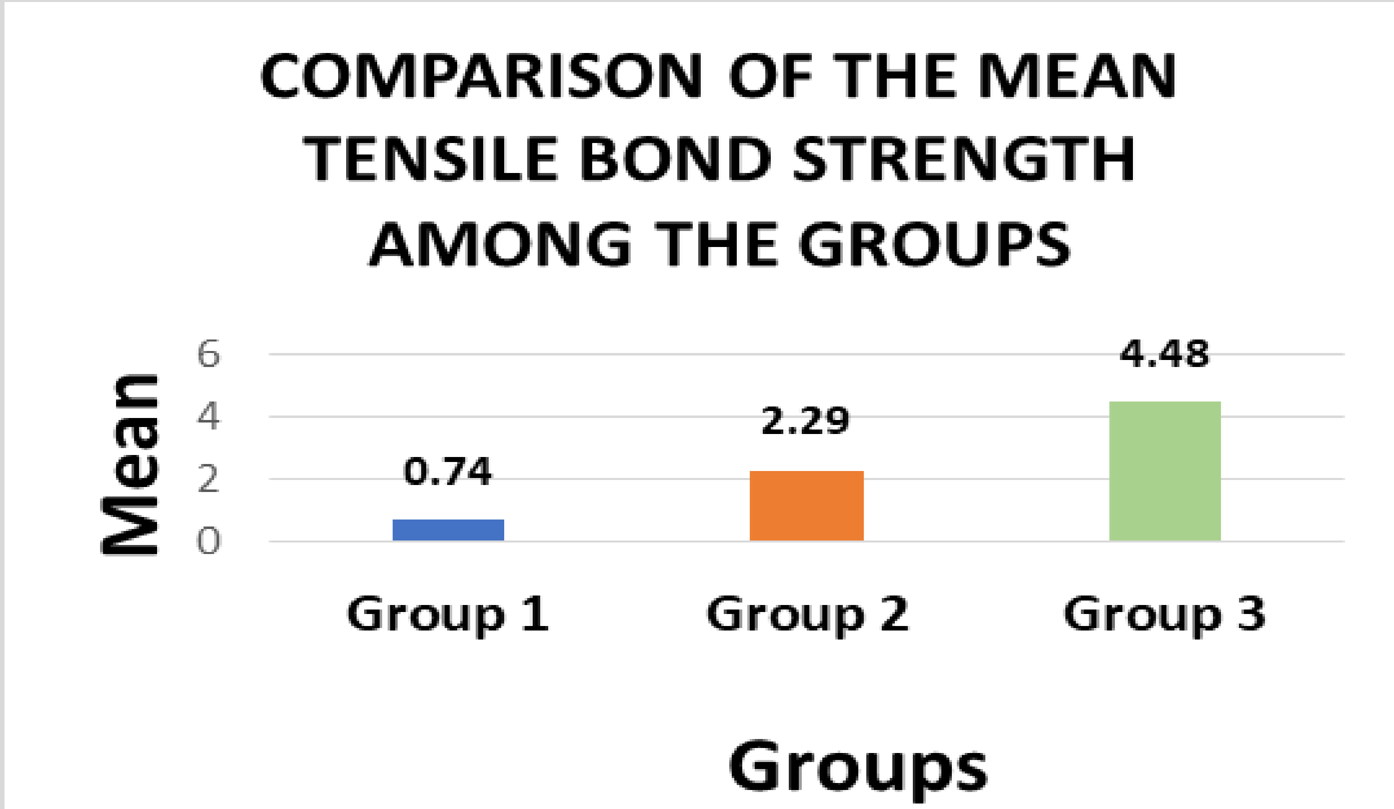
Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	p value	Statistic	df	p value
Group 1	.113	20	.200*	.950	20	.362
Group 2	.171	20	.129	.917	20	.086
Group 3	.116	20	.200*	.936	20	.201

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 1: Mean Tensile Bond Strength among the Groups

Groups	N	Minimum	Maximum	Mean	S.D
Group 1	20	.51	1.00	.74	.154
Group 2	20	1.95	2.73	2.29	.247
Group 3	20	4.02	4.91	4.47	.289



Graph 1:

Table 2: Comparison of the mean tensile bond strength among the groups using anova

Groups	N	Minimum	Maximum	Mean	S.D	P value
Group 1	20	.51	1.00	.74	.154	0.001*
Group 2	20	1.95	2.73	2.29	.247	
Group 3	20	4.02	4.91	4.47	.289	

*significant

Mean tensile strength was lower in Group 1 (0.74 ± 0.154) followed by Group 2 (2.29 ± 0. 247) and Group 3 (4.48 ± 0.289). ANOVA test was applied to compare the mean tensile strength among the groups. ANOVA test showed statistically significant difference among the different groups (p=0.001).

Table 3: Inter group comparison using post-hoc bonferroni

	Mean Difference	p value	95% Confidence Interval	
			Lower Bound	Upper Bound
Group 1 Vs Group 2	-1.54	.001*	-1.72	-1.35
Group 1 Vs Group 3	-3.72	.001*	-3.91	-3.54
Group 2 Vs Group 4	-2.18	.001*	-2.37	-2.00

*significant

Inter group comparison was done using Post-hoc Bonferroni test. Statistically significant difference with respect to tensile strength was seen between all the groups (p=0.001).

Statistical Analysis

SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM corp. released 2011] was used to perform the statistical analysis

- Data was entered in the excel spread sheet.
- Data was subjected to normalcy test (Shapiro -wilk test). Data was normally distributed. Hence Parametric tests were applied. Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables.
- Inferential statistics like

ANOVA test was applied to compare the mean tensile strength among the groups with post-hoc Bonferroni for inter group comparison.

- The level of significance is set at 5%.

Discussion

Resilient lining materials have provided a topic for discussion, research and controversy for many decades. Resilient liners can repair inflamed mucosa, and more evenly distributes the functional strain on the teeth. This makes them beneficial in removable prosthodontics. The denture foundation area and the fit of the denture is increased leading to better retention of the prosthesis.[3]

The two types of resilient liner materials available today are silicone and acrylic-based. There are versions of both groups that have been heat or auto-polymerized. Auto polymerized resilient liner materials allow the clinician to reline a removable denture directly, intraorally. This method is faster than using heat-polymerized (laboratory processed) systems, and a patient is not without the prosthesis during the time required for laboratory procedures. However, it is difficult to produce liner materials of the optimum thickness with the auto polymerized technique. The optimum thickness has been reported as approximately 2.5 to 3 mm, which is needed to provide good shock absorption.[22]

Acrylic resin-based resilient liner materials generally consist of polymers and monomers. When submerged in water, these materials go through two processes: the polymer absorbs the water and plasticizers and other soluble components leak into the water. It has been proposed that the plasticizer, which is also responsible for preserving material softness, is what gives the plasticized acrylic resins their initial softness.[22]

Molloplast B is a silicone based permanent soft reliner. It is a heat-curing one-component silicone, permanent soft relining material, suitable for PMMA based denture base materials. Molloplast B reliner has many benefits. It looks like natural gingiva, is comfortable to wear, and is resistant to mechanical pressure. It is indicated for sharp ridged alveolar processes, cushioning of the denture against sharply defined mylohyoid line or foramen mentale. It is also indicated for post-damming and stabilization of position of the maxillary and mandibular dentures by increased adhesion. It is also indicated to cover larger defects caused by malformations or surgeries with obturators.

One of the most significant problems is the loss of adhesion between the resilient lining material and the denture base material. Poor adhesion between these 2 materials can lead to functional and hygienic problems if they separate from each other during use. The chemical nature of the resilient lining material as well as environmental elements like temperature and storage circumstances might cause the bond between it and the denture base material to disintegrate. The combined impacts of ethanol loss, water absorption, and plasticizer loss have been identified as the mechanism responsible for the change in viscoelasticity of the resilient lining materials. Consequently, the denture base material and the resilient lining material separate as mastication forces are transferred from the outside to the bond surface. This problem may be eliminated by using surface treatments before applying the resilient lining material. Surface treatments result in polymethyl methacrylate (PMMA) irregularities that can help with mechanical locking of the resilient lining material, strengthening the link between the resilient lining material and the denture base.[27]

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. Tensile bond strength values are highest for acid etched group and least for sandblasting group. These findings are in accordance with the studies by Amin et al and Gundogdu (2014) whereby they reported that roughening the acrylic resin base with air-borne particle abrasion before applying the resilient lining material weakened the bond. However, Craig and Gibbons 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.[33]

An invitro experiment study was done to evaluate the effect of different surface treatments on the bond strength of Molloplast B and Ufi Gel P resilient lining materials to an acrylic resin denture base. Three millimeters of heat-polymerized acrylic resin were removed from the thin midsection of ninety-six dumbbell-shaped specimens. The specimens were divided into 6 groups according to their surface treatments: no surface treatment (control group), 36% phosphoric acid etching (acid group), erbium: yttrium-aluminum-garnet (Er:YAG) laser (laser group), airborne-particle abrasion with 50-mm Al_2O_3 particles (abrasion group), an acid + laser group, and an abrasion + laser group. Based on the type of resilient lining material utilized, each set of specimens was further separated into two subgroups: auto polymerized silicone-based resilient liner (Ufi Gel P) and heat-polymerized silicone-based resilient liner (Molloplast B). Following the polymerization process, each specimen was kept for a week at 37°C in distilled water. Tensile bond strength was greatest in specimens from the acid group and lowest in specimens from the abrasion group. The binding strength of Molloplast B was substantially higher than that of Ufi Gel P.[27]

In order to compare the properties of denture bases fabricated by compression molding and injection molding technique a laboratory study was conducted which compared incisal pin opening, dimensional accuracy, and laboratory working time for dentures fabricated by injection molding technique with dentures constructed by the conventional compression molding technique. Six maxillary and six mandibular dentures were divided into two groups for evaluation: group 1 (control), which was injection molded with a long cure cycle, and group 2, which was compression molded using the same material. The groups were compared using t tests and analysis of variance (ANOVA). The injection molding technique, using polymethyl methacrylate, was a more accurate method for processing dentures.[12]

To evaluate the tensile bond strength of both hard and soft denture reline materials on denture bases fabricated by 3D printing and computer-aided design and computer-aided manufacture (CAD-CAM) milling technology, an in vitro study was conducted. Thirty denture base specimens were injected, machined, and printed, and then bonded to five distinct denture reline materials: hard chairside reline (Tokuyama Rebase ii and Kooliner), soft chairside reline (Coe Soft and PermaSoft), and hard laboratory reline (ProBase Cold). Prior to tensile testing, specimens of each reline material were split into 5 groups (n=10) and kept in distilled water for a whole day. In addition to determining the failure mode, the maximum tensile stress values prior to failure were noted. However, the printed denture base group demonstrated significantly lower values of tensile bond strength when relined with Kooliner. The hard laboratory reline material had the greatest values when compared to the soft chairside relining material in terms of denture reline type. The printed denture base materials relined with soft chairside relining materials exhibited adhesive failures more frequently than the milled and injected denture base groups, which displayed cohesive and mixed modes of failure. The study found that, for all chairside relining groups, milled denture bases had the highest values of tensile bond strength, while printed denture bases had significantly lower values compared to injection and milled denture bases with the PermaSoft, Tokuyama Rebase ii, and ProBase Cold denture relines.[36]

A study was conducted 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. 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. Three groups (acid etching, sandblasting, and control; no surface treatment) and two subgroups for each group—Molloplast-B (a heat-cured soft lining material) and Mollosil (a self-cured soft lining material)—were randomly assigned to the samples. Each subgroup's samples were divided in half; the first half was created and submerged in synthetic saliva for seven days, while the second half was created the day the test was administered. For each subgroup, the tensile bond strength was significantly higher for the acid-etched samples; similarly, the tensile strengths for the Molloplast-B lined samples were significantly higher for each surface treatment and immersion in artificial salivary solution showed decrease in tensile strengths for each sub-group.[33]

This study was taken up to compare the tensile bond strength of soft denture liner material on denture bases fabricated by compression molding, injection molding and milled CAD CAM technique following surface treatment with 36 % phosphoric acid.

120 cuboidal blocks were prepared from PMMA using compression molding, injection molding and milled CAD-CAM technique. 60 specimens were prepared by processing the denture liner material against the two opposing denture base resin blocks. In the first group, a total of twenty specimens were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through compression molding technique and surface treated with 36 % phosphoric acid. In the second group, a total of twenty specimens were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through injection molded technique and surface treated with 36% phosphoric acid. In the third group, a total of twenty specimens were made by processing the denture liner material against the two opposing denture base resin blocks fabricated through milling CAD-CAM discs and surface treated with 36 % phosphoric acid.

All specimens were placed in artificial saliva for 24 hours before testing. Denture specimens were placed under tension and were pulled apart until failure in a universal testing machine at a crosshead speed of 5 mm/min. Maximum tensile stress values before failure was recorded in newtons (N).The tensile bond strength values (in MPa) was calculated as the maximum load(N) divided by the cross-sectional area of the interface (mm^2). The cross-sectional area (10×10 mm) will be 100 mm^2 for all denture base specimens.

Results show that the tensile bond strength was highest between milled CAD-CAM and Molloplast B after surface treatment with 36% phosphoric acid, followed by mean tensile bond strength between injection molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid. The mean bond strength between compression molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid was found to be least. All the results obtained were statistically significant. Thus it can be concluded within the limitations of this study that tensile bond strength is highest when milled CAD-CAM PMMA surface treated with 36% phosphoric acid is lined by Molloplast B denture liner material.

Conclusion

Molloplast B soft reliner is a permanent soft reliner-silicone based material for processing in dental laboratories. It has a wide range of applications in prosthodontics. It is useful in conditions such as sharp ridged alveolar processes, cushioning of the denture against sharply defined mylohyoid line or foramen mentale, post-damming and stabilization of position of the maxillary and mandibular dentures and also to cover larger defects caused by malformations or surgeries with obturators.

Within the limitations of this study, it is concluded that,

- The tensile bond strength between permanent soft denture liner to compression molded denture base specimens improved after surface treatment with 36% phosphoric acid.
- The tensile bond strength between permanent soft denture liner to injection molded denture base specimens improved after surface treatment with 36% phosphoric acid.
- The tensile bond strength between permanent soft denture liner to milled CAD-CAM denture base specimens improved after surface treatment with 36% phosphoric acid.
- Hence it was concluded that the tensile bond strength was highest between milled CAD-CAM and Molloplast B after surface treatment with 36% phosphoric acid, followed by mean tensile bond strength between injection molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid. The mean bond strength between compression molded denture base specimens and Molloplast B after surface treatment with 36% phosphoric acid was found to be least.

References

1. Amin WM, Fletcher AM, Ritchie GM. A study of the interface between resilient denture liners and polymethylmethacrylate. Engineering in Medicine. 1980 Apr;9(2):75-80.
2. Khan Z, Martin J, Collard S. Adhesion characteristics of visible light-cured denture base material bonded to resilient lining materials. The Journal of Prosthetic Dentistry. 1989 Aug 1;62(2):196-200.
3. Kawano F, Tada N, Nagao K, Matsumoto N. The influence of soft lining materials on pressure distribution. The Journal of Prosthetic Dentistry. 1991 Apr 1;65(4):567-75.

4. Jepson NJ, McCabe JF, Storer R. Evaluation of the viscoelastic properties of denture soft lining materials. Journal of Dentistry. 1993 Jun 1;21(3):163-70.
5. Kutay O. Comparison of tensile and peel bond strengths of resilient liners. The Journal of Prosthetic Dentistry. 1994 May 1;71(5):525-31.
6. Waters MG, Jagger RG, Jerolimov V, Williams KR. Wettability of denture soft-lining materials. The Journal of Prosthetic Dentistry. 1995 Dec 1;74(6):644-6.
7. Emmer Jr TJ, Emmer TJ, Vaidynathan J, Vaidynathan TK. Bond strength of permanent soft denture liners bonded to the denture base. The Journal of Prosthetic Dentistry. 1995 Dec 1;74(6):595-601.
8. Al-Athel MS, Jagger RG. Effect of test method on the bond strength of a silicone resilient denture lining material. The Journal of prosthetic dentistry. 1996 Nov 1;76(5):535-40.
9. Waters MG, Jagger RG. Mechanical properties of an experimental denture soft lining material. Journal of dentistry. 1999 Mar 15;27(3):197-202.
10. McCabe JF. A polyvinylsiloxane denture soft lining material. Journal of dentistry. 1998 Jul 1;26(5-6):521-6.
11. Nogueira SS, Ogle RE, Davis EL. Comparison of accuracy between compression-and injection-molded complete dentures. The Journal of prosthetic dentistry. 1999 Sep 1;82(3):291-300.
12. Aydın AK, Terzioğlu H, Akınay AE, Ulubayram KE, Hasırcı N. Bond strength and failure analysis of lining materials to denture resin. Dental materials. 1999 May 1;15(3):211-8.
13. Tan HK, Woo A, Kim S, Lamoureux M, Grace M. Effect of denture cleansers, surface finish, and temperature on Molloplast B resilient liner color, hardness, and texture. Journal of Prosthodontics. 2000 Sep;9(3):148-55.
14. Usanmaz A, Latifoğlu MA, Doğan A, Akkaş N, Yetmez M. Mechanical properties of soft liner–poly (methyl methacrylate)-based denture material. Journal of applied polymer science. 2002 Jul 18;85(3):467-74.
15. McCabe JF, Carrick TE, Kamohara H. Adhesive bond strength and compliance for denture soft lining materials. Biomaterials. 2002 Mar 1;23(5):1347-52.
16. Pinto JR, Mesquita MF, Henriques GE, de Arruda Nóbilo MA. Effect of thermocycling on bond strength and elasticity of 4 long-term soft denture liners. The Journal of prosthetic dentistry. 2002 Nov 1;88(5):516-21.
17. Meşe A, Güzel KG, Uysal E. Effect of storage duration on tensile bond strength of acrylic or silicone-based soft denture liners to a processed denture base polymer. Acta Odontologica Scandinavica. 2005 Jan 1;63(1):31-5.
18. Usumez A, Inan O, Aykent F. Bond strength of a silicone lining material to alumina-abraded and lased denture resin. Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2004 Oct 15;71(1):196-200.
19. Yanikoglu N, Denizoglu S. The effect of different solutions on the bond strength of soft lining materials to acrylic resin. Dental materials journal. 2006;25(1):39-44.
20. Hermann C, Mesquita MF, Consani RL, Henriques GE. The effect of aging by thermal cycling and

mechanical brushing on resilient denture liner hardness and roughness. Journal of Prosthodontics. 2008 Jun;17(4):318-22.

21. Mutluay MM, Ruyter IE. Evaluation of bond strength of soft relining materials to denture base polymers. dental materials. 2007 Nov 1;23(11):1373-81.
22. 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. The Journal of prosthetic dentistry. 2008 Feb 1;99(2):153-9.
23. Hatamleh MM, Maryan CJ, Silikas N, Watts DC. Effect of net fiber reinforcement surface treatment on soft denture liner retention and longevity. Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry. 2010 Jun;19(4):258-62.
24. Geramipanah F, Zeighami S. Effect of denture cleansers on tensile bond strength of soft liners to denture base resin. Journal of Iranian Dental Association. 2013 Jul 10;25(3):190-7.
25. Geramipanah F, Ghandari M, Zeighami S. The effect of thermocycling on tensile bond strength of two soft liners. Journal of Dentistry (Tehran, Iran). 2013 Sep;10(5):405.
26. Korkmaz FM, Bagis B, Özcan M, Durkan R, Turgut S, Ates SM. Peel strength of denture liner to PMMA and polyamide: laser versus air-abrasion. The journal of advanced prosthodontics. 2013 Aug 1;5(3):287-95.
27. Gundogdu M, Duymus ZY, Alkurt M. Effect of surface treatments on the bond strength of soft denture lining materials to an acrylic resin denture base. The Journal of prosthetic dentistry. 2014 Oct 1;112(4):964-71.
28. Meşe A. Bond strength of soft denture liners following immersion of denture cleanser. Biotechnology & biotechnological equipment. 2006 Jan 1;20(3):184-91.
29. Tugut F, Coskun ME, Dogan DO, Kirmali O, Akin H. Tensile bond strength between soft liners and two chemically different denture base materials: effect of thermocycling. Journal of Prosthodontics. 2016 Jun;25(4):319-23.
30. Patel H, Kumar R, Ponnanna AA, Bithu AS, Shah K, Prajapati S. The effect of primer on bond strength of silicone prosthetic elastomer to polymethylmethacrylate: an in vitro study. Journal of clinical and diagnostic research: JCDR. 2015 Mar;9(3):ZC38.
31. Mittal M, Kumar SA, Sandhu HS, Iyer SR, Ahuja RS. Comparative evaluation of the tensile bond strength of two silicone based denture liners with denture base resins. medical journal armed forces india. 2016 Jul 1;72(3):258-64.
32. Swapna C, Hareesh MT, Renjith M, Ahmed A, Abraham IA, Gopinathan M. An evaluation of the effect of surface treatment on the bond strength of soft denture liners. Journal of International Oral Health. 2016 Sep 1;8(9):922.
33. Sodha J, Shah RJ, Patel A, Mehta S, Sutariya D, Bajania D. 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. growth.;11:12.
34. Muddugangadhar BC, Mawani DP, Das A, Mukhopadhyay A. Bond strength of soft liners to denture base resins and the influence of different surface treatments and thermocycling: A systematic

review. The Journal of prosthetic dentistry. 2020 Jun 1;123(6):800-6.

35. Yildirim AZ, Unver S, Mese A, Bayram C, Denkbas EB, Cevik P. Effect of argon plasma and Er: YAG laser on tensile bond strength between denture liner and acrylic resin. The Journal of Prosthetic Dentistry. 2020 Dec 1;124(6):799-e1.

36. Awad AN, Cho SH, Kesterke MJ, Chen JH. Comparison of tensile bond strength of denture reline materials on denture bases fabricated with CAD-CAM technology. The Journal of prosthetic dentistry. 2021 Aug 6.

Legend Figures

Figure 1: Armamentarium Used in the Study

Fabrication of denture base specimens by compression molding technique

Figure 2: Wax samples for fabrication of specimens

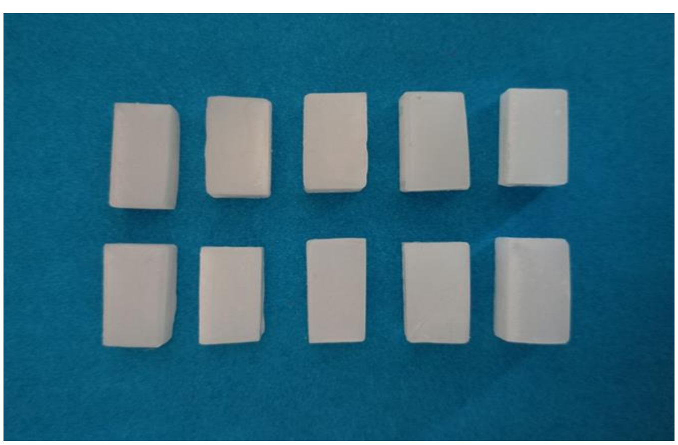


Figure 3: Dimensions of wax samples used for fabrication of specimens

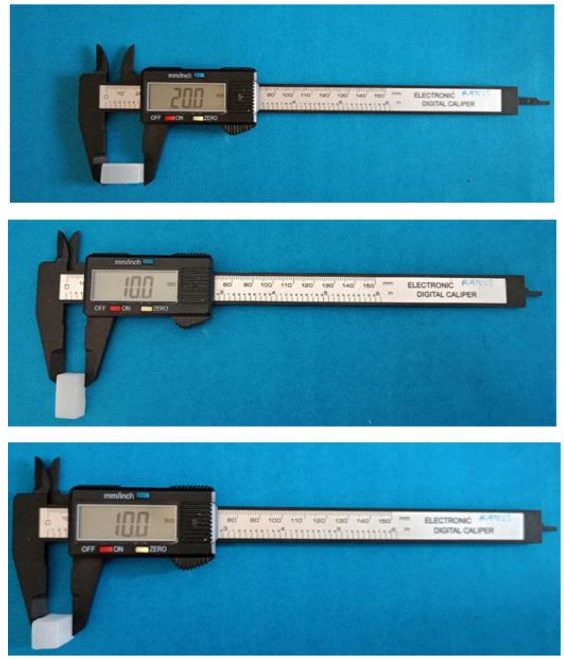


Figure 4: Wax samples invested for fabrication of specimens

Figure 5: Mold Space after Dewaxing

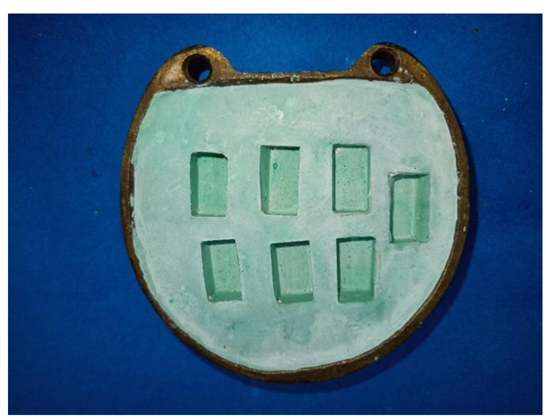


Figure 6: Packing of Mold Space with Heat Cured Pmma with Application of Cellophane Sheet to Remove Excess Material

Figure 7: Heat cured pmma after removal of excess material before closure of flask for acrylization

Figure 8: Denture Base Specimens

Figure 9: Fabrication of specimens by injection molded technique

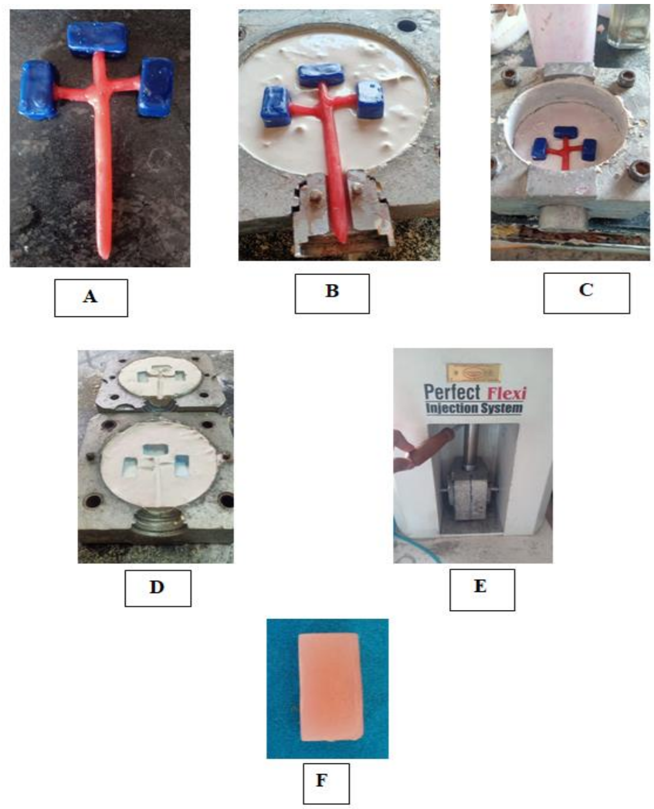


Figure 10: Fabrication of specimens through milling of pmma cad - cam discs.

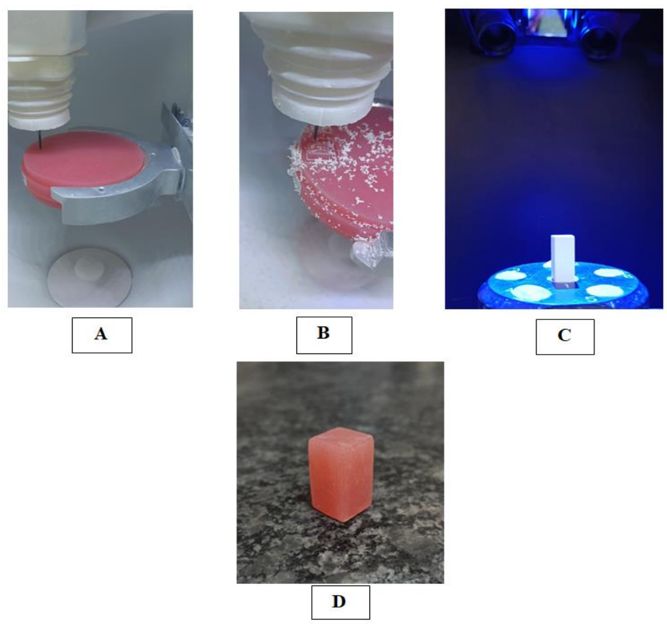


Figure 11: Dimensions of specimens 20*10*10 mm

Figure 12: Denture base spicimens fabricated by compression molding, injection molding and milled cad - cam technique

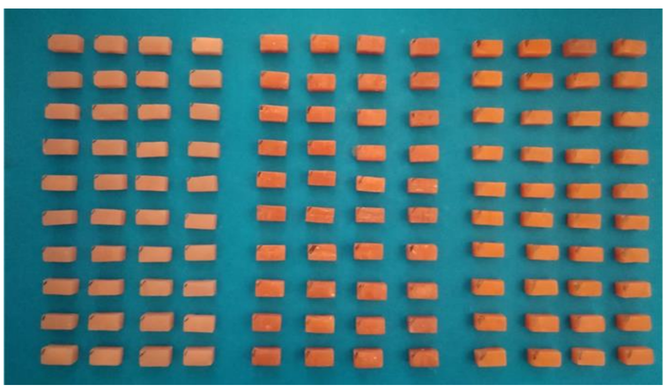


Figure 13: Surface treatment of specimens with 36% phosphoric acid

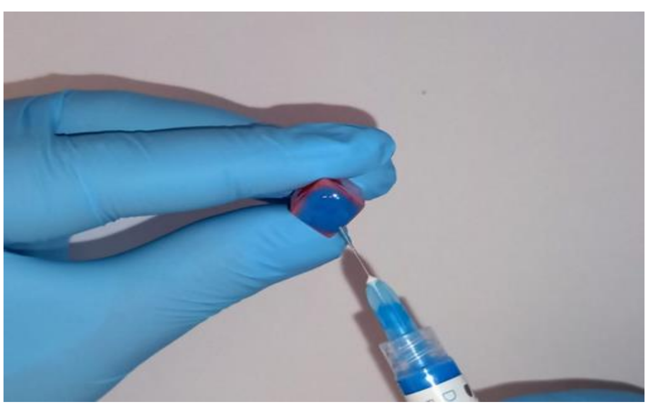


Figure 14: Specimens washed in water for 30 seconds

Figure 15: Surface dried for 20 seconds with air spray

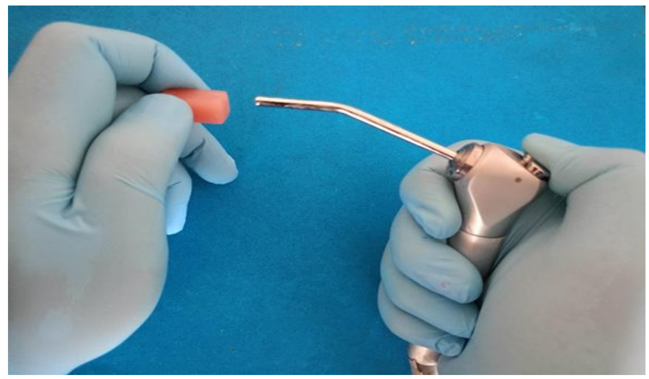


Figure 16: 3 mm space between two specimens for incorporation of base plate wax

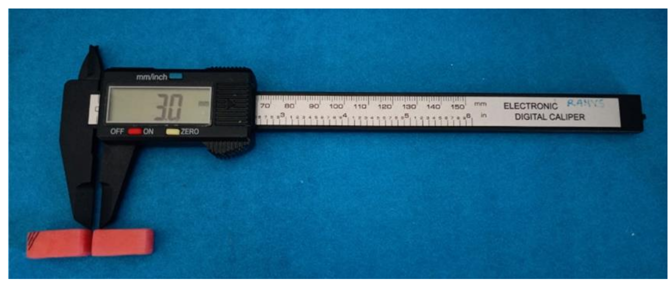


Figure 17: Baseplate wax is filled into the 3 mm space between two specimens

Figure 18: Sixty samples with baseplate wax incorporated in between two pmma specimens

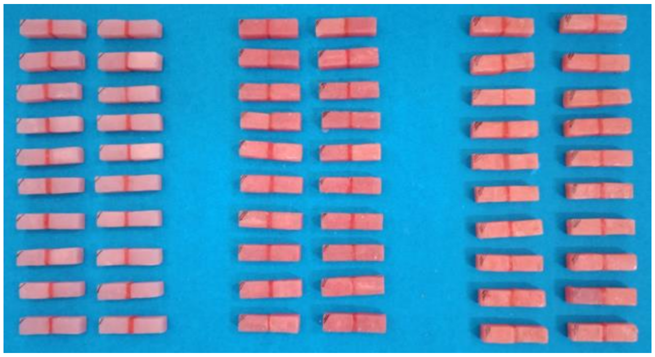


Figure 19: Samples invested using dental stone

Figure 20: Dewaxing of samples was done

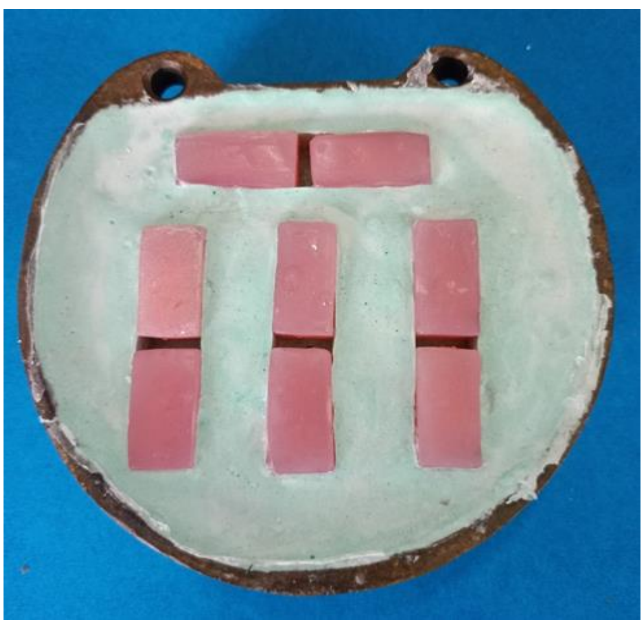


Figure 21: Soft liner adhesive applied on the bonding surface of the specimens.

Figure 22: Incorporation of Molloplast B Soft Liner in the Mold Space

Figure 23: Pmma specimens with molloplast b incorporated between two blocks

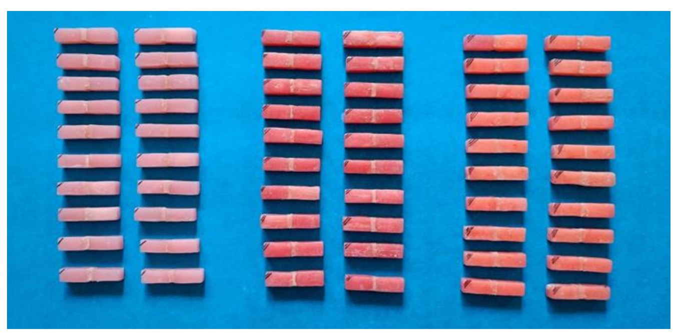


Figure 24: All specimens stored in artificial saliva solution

Figure 25: Universal testing machine [mecmesin multitest 10- i]

Figure 26: Samples loaded onto the universal testing machine

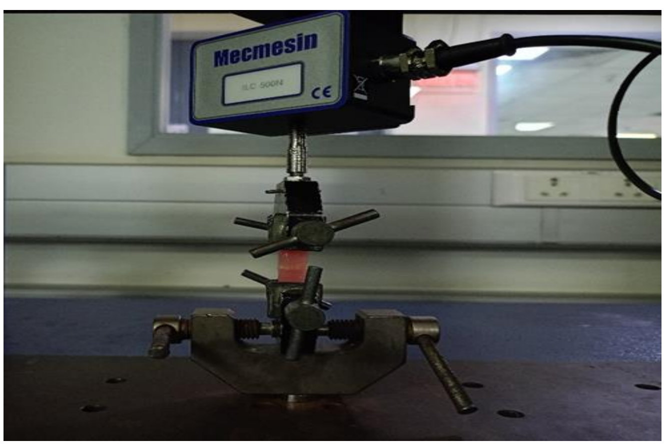


Figure 27: Load applied till debonding occurs