International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Simple Method for Increasing the Bond Strength between Denture Base and Soft Relining Material – An Invitro Study

Ilian Hristov[1], Dobromira Shopova[2], Tanya Bozhkova[3], Lyubomir Grozev[4], Victor Hadjigaev[5]

Department of Prosthodontics, Faculty of Dental Medicine, Medical University, Plovdiv, Bulgaria

Abstract:***Statement of the problem: The bond strength between the denture basis and the soft relining material is of crucial importance for the duration of the so called "two-layer" dentures. The aim of the study: The aim of the study is to propose a new simple method for increasing the bond strength between denture basis and soft relining material.Materials and methods: Two commonly used dental materials were used: PMMA Meliodent - acrylic resin and Elite Soft Relining – soft relining (silicone) material. 60 cylindrical samples were made (length (L)=30mm and diameter (D)=5mm). Half of this length (15mm) was made of PMMA Meliodent and the other half (15mm) was made of VPS Elite Soft Relining.Acrylic pearls for additional mechanical retention were also used. A total number of 60 samples were made, divided equally in two groups. For the first group the bond was realized onlyby means of the manufacturer's primer. It served as a control group. For the second group except the primer, four acrylic pearls per sample were added. Both groups were tested for tensile bond strength with the help of a device LMT-100 (LAM Technologies). The results were analyzed by using ANOVA test method.Results: The mean tensile bond strength of the first (control) group was 0.744 MPa and for the second 1.380 MPa respectively.Conclusion: Within the limitations of the study it was concluded that the use of additional mechanical retention increases the bond strength almost twice, compared to the control group.***

Keywords:soft relining materials, bond strength

1. Introduction

Soft relining materials are usually used when we have patients with: very narrow alveolar ridges, covered with thin mucosa, severe undercuts, painful zones, xerostomia etc. Durability of the so called "two-layer" denture depends primary on the bond strength between the two materials (the PMMA basis from one hand and the SRM from the other). Moodhy and Jagger emphasize the role of the different methods for investigating the bond strength [1]. Various authors suggest several types of tests for this purpose [2; 3; 4; 5]. Naik and Jabade consider the tensile bond strength tests to be very effective, because they are similar to the action of the vertical forces during the chewing cycle. These tests present cutting surface, quite informative for the structure of the two layers right on the spot of the rupture [6]. This statement is in agreement withMutluayetRuyter [7]. The energy, that is necessary for tearing the samples apart, depends on: the nature of the material, time of exposition and kind of solution, they have been kept. The velocity of the experiment, as well as the elastic properties of the material are also of primary importance [8; 9; 10]. The bond strength is also dependant on: the type of polymer of the denture basis and the SRM that have been used [11, 12; 13]. The best results are achieved when chemically homogenous materials are connected to similar ones [14].

When the materials are different by chemical origin (PMMA and VPS for example), obviously there is no chemical bond between them. In this case many authors suggest different methods, use of:

- Sandblasting or lasers for increasing the contact surface
- Different primers for additional chemical bond [15, 16, 17, 18].

2. Materials and Methods

For accomplishing this task 60 cylindrical samples were made, with length (L)=30mm and diameter (D)=5mm. Half of this length (15mm) was made of PMMA **Meliodent [**KULZER**]** and the other half (15mm) was made of VPS soft relining material **Elite Soft Relining [Zhermack]**(fig.1).

Figure1: Dimensions of the sample

For this purpose we used a brass form, which allows manufacturing each time samples with the same dimensions (fig.2).

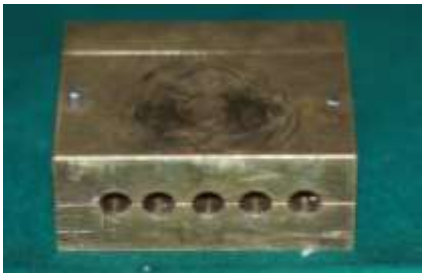

Figure 2: The brass form

First the whole form was filled with PMMA and polymerized according to the manufacturer's instructions. Then the brass form was opened, the samples taken out and

cut in the middle with a diamond instrument. The achieved smooth surfaces were cleaned with alcohol and dried. ThePrimer–Elite Soft Relining was used over the contact zone and 4 plastic pearls (diameter=0.6mm)[3] were added (fig.3, 4).

Figures 3 and 4: The plastic pearls, used for additional retention

We waited the primer to dry for a minute and then put back the samples in the brass form and the empty space was filled with Elite Soft Relining. The polymerization process was done according to the manufacturer's instructions. 30 samples, using this method and another 30 without any pearls serving as a control group were made.

Figure 5: The polymerized samples

The maximal bond strength (**P**), was calculated, using the formula **P=F/S**, where (**F)** is the force needed for tearing the samples apart in (**N**) and the (**S)** is the cross-section, measured in mm^2. The final results were measured in **MPa**.The formula $\mathbf{S=\pi.r^2}$ for measuring the cross-section of the samples was used. The result of the calculation was: $S=3.14x2.5^2=\mathbf{19.625mm^2}$.

To measure the tear bond strength between the denture base and the soft relining material, the samples were investigated using a device for measuring the bond strength - **LMT-100 (LAM Technologies).**

Figure 6: The device **LMT-100**

From the software of the apparatus a speed of 0.25mm/sec was set.

Figure 7: The parameters of the investigation

A graphics for every sample has been drawn. The software copies the entire experiment and generates a **XLS** file, which gives the opportunity to analyze the data.

Figure 8: The beginning of the experiment

Figure 9: The elastic deformation of the sample

Figure 10: The end of the experiment

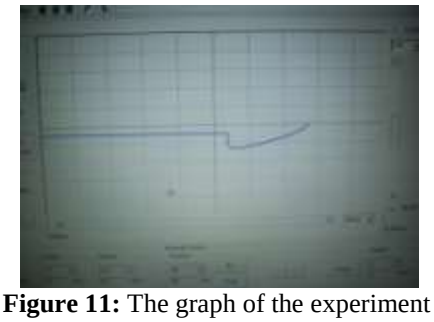

Figure 11: The graph of the experiment

3. Results and Discussion

The received data was put in a table and later submitted to a statistical analysis.We used the graph attachment of the „R"-Z* sample for calculating the number of samples required for the experiment. It was calculated that the requisite number of test samples for obtaining 95% confidence interval are 26.593. After the correction we figured out the requisite number of test samples for obtaining 80% power of the analysis are 29. Finally 30 test samples in each group were made. For the statistics **One Way ANOVA** analysis was used. The final results from the tests are illustrated in table 1.

Table1: The maximal value of the samples from the control group and the group with the retentions

№	*Control group*	*Group with retentions*
1	0,718471338	1,263694268
2	0,377070064	1,278980892
3	0,448407643	1,513375796
4	0,519745223	1,385987261
5	0,529936306	1,263694268
6	0,580891720	1,278980892
7	0,662420382	1,421656051
8	0,672611465	1,329936306
9	0,733757962	1,355414013
10	0,794904459	1,635668790
11	0,968152866	1,304458599
12	0,331210191	1,314649682
13	0,377070064	1,304458599
14	0,382165605	1,645859873
15	0,535031847	1,447133758
16	0,555414013	1,543949045
17	0,575796178	1,574522293
18	0,575796178	1,788535032
19	0,718471338	1,228025478
20	0,759235669	1,268789809
21	0,789808917	1,605095541
22	0,901910828	1,126114650
23	1,513375796	1,243312102
24	1,085350319	1,187261147
25	0,993630573	1,019108280
26	1,121019108	1,273885350
27	1,090445860	1,635668790
28	1,003821656	1,355414013
29	0,998726115	1,543949045
30	1,019108280	1,263694268

Table 2: Average values and standard deviation of the test samples in MPa

	№	*Sx*	*SD*	*Min. Value*	*Max. Value*
Control group	30	0.744	0.279	0.331	1.513
Group with retentions	30	1.380	0.177	1.019	1.789

Essential difference between the average values of the two groups is noticeable. Respectively 0.744 MPa for the first group and 1.380 MPa for the second one. The correlation of the average values is presented graphically by the following diagram:

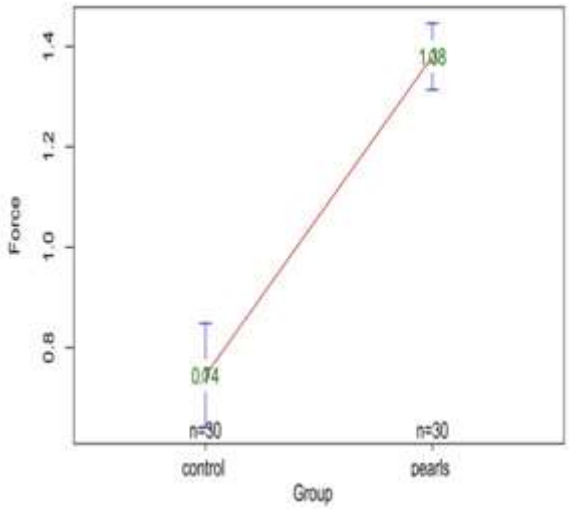

Diagram 1: Correlation of the averagevalues of the two groups (MPa)

As it is visible on the diagram, the average values from the tensile bond strength tests of the group with the mechanical retentions added, are **almost as twice as higher**, compared to the control group. The presentation of the data with another type of graph, demonstrates an overlap in values, because of the standard deviation.

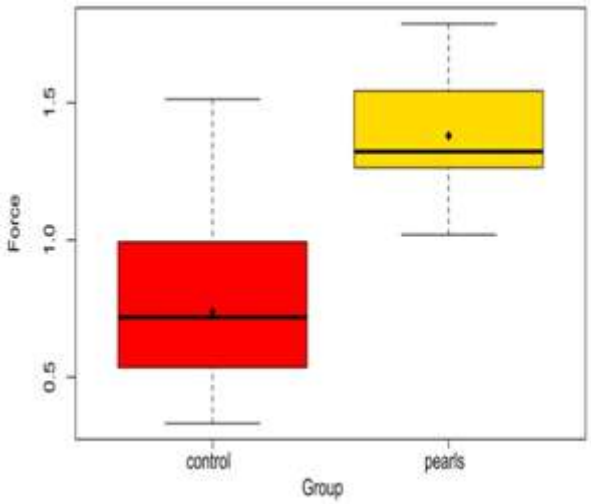

Diagram 2: The average values and the overlap in values of the two groups (MPa)

In order to check, whether the achieved from the experiments results are not due to some intergroup variations, the **One Way ANOVA** test was applied. This analysis proves the presence of statistically essential difference ($F=9.63$, $p<0.001$).

Table 3: Results from ANOVA test:

	Degree of freedom	Sum of squares	Average of squares	F	P<0.001
group	1	6.06	6.06	9.63	0.00
residues	58	3.16	0.05		

The results from the statistical analysis undoubtfully reveal that the use of plastic pearls (D=0.6mm), increases almost twice the values of the tensile bond strength of the group with mechanical retentions, compared to the control group. These results are in agreement with similar investigations of other authors (Craig et Gibbons [19], Storer [20]).

The primer usually consists of two active functional groups. The first one connects to the PMMA basis and the second one to the VPS soft relining material. Thus the plastic pearls are bonded **chemically** to the PMMA, due to the primer. On the other hand the retentional zones are enough for the silicone material to penetrate the undercuts and in this way to insure additional **mechanical bond**, besides the chemical one. The use of mechanical retentions by no means exclude the use of primers.

4. Conclusion

We consider that the combination of chemical and mechanical bond leads to better results in clinical conditions.The problem with the bond between the denture basis and the SRM, is also considered to be the basic reason for the skeptical attitude of the most of the clinicians towards these materials. In our opinion this method is cheap and very easy to perform. It can be done both in clinical and laboratory conditions. It is a simple alternative to the methods using sandblasting, lasers, etc, because there is no need of any expensive equipment, experienced personnel and additional skills.

5. Abbreviations

SRM – Soft relining material
VPS – Vinyl Polysiloxane

6. Acknowledgements

This investigation was partially supported by University grant – **DP-06/2013** of Medical University – Plovdiv, Bulgaria.

References

[1] Moodhy, A. etR. Jagger. Effect of test method on the bond strength of a silicone resilient denture lining materia. J Prosthet Dent 1996;76: 535-540.
[2] Aleksandrov, Sv. Study of the bond strength between a laboratory resin and a base dental alloy using micro and macro mechanical cutting tests. Doctoral dissertation. Medical University Plovdiv, 2015.
[3] Atanasov, Iv. Dental materials, Sofia Smile Centre, Sofia, 2013:39:43
[4] Dikova, C. Dentalmaterials. PartII, MedicalUniversityVarna. 2015: 55
[5] Yankova, M., Yordanov, B. Applicationofelasticdentalmaterialsonapatientwithpartially and fullyedentulousjaws. Infodent. 2014; 2:3-11.
[6] Naik, A. etJ. Jabade. Comparison of tensile bond strength of resilient soft liners to denture base resins. J Indian Prosthodont Soc. 2005; 5: 86-88.
[7] Mutluay, M. etI. Ruyter. Evaluation of bond strength of soft relining materials to denture base polymers. Dent Mater. 2007; 23: 1373-1381.
[8] Yanikoglu, D., S. Denizoglu.The Effect of Different Solutions on the Bond Strength of Soft Lining Materials to Acrylic Resin. Dental Materials Journal. 2006; 25 (1): 39-44.
[9] Mese, A., K. Guzel, E. Uysal. 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; 63: 31-35.
[10] Vergani, C., R. Sey, J. Reis et al. Effect of Water Storage on the Shear Strength and Fatigue Limit of the Reline Resin Bond to Denture Base Resins. J Adhes Dent. 2010; 12: 319-327.
[11] Arena, C., D. Evans, T. Hilton. A comparison ofbond strengths among chairside hard reline materials. Journalof Prosthetic Dentistry. 1993,70**:**126.
[12] Cucci, A., R. Rached, E. Giampaoloet al. Tensile bond strengths of hard chairside reline resins asinfluenced by water storage. Journal of Oral Rehabilitation. 1999; 26: 631–634.
[13] Hakan, D., A. Dogan, O. Dogan et al. Peel Bond Strength of Two Silicone Soft Liners to a Heat-cured Denture Base Resin. J Adhes Dent. 2011; 13: 579–584.
[14] Ahmad, F., M. Dent, N. Yunus, Shear Bond Strength of Two ChemicallyDifferent DentureBase Polymers to Reline Materials.Journal of Prosthodontics.2009; 18: 596–602.
[15] El-Hadary, A., J. Drummond. Comparative study of water sorption, solubility, and tensile bond strength of two soft lining materials. J Prosthet Dent 2000; 83:356-361
[16] Holt, R., C. Zylinski, M. Duncanson. Force Versus Time Profiles of Selected Heat-Processed Denture Liners. Int J Prosthodont.1991; 4: 164-168.
[17] Minami H. ,S. Suzuki, H. Ohashi et al. Effect of Surface Treatment on the Bonding of an Autopolymerizing Soft Denture Liner to a Denture Base Resin.Int J Prosthodont. 2004; 17: 297–301.
[18] Minami, H., S. Suzuki, H. Ohashi et al. In vitro evaluation of the bonding of auto-polymerizing soft denture liner to cobalt–chromium alloy. Journal of Oral Rehabilitation. 2005; 32: 454–460.
[19] Craig, R. etP. Gibbons. Properties of resilient denture liners. J Am Dent Assoc. 1961; 63: 382-390.
[20] Storer, R. Resilient denture base materials. Part 1. Introduction and laboratoryevaluation. Br Dent J. 1962; 113: 195–203.

Author Profile

DrIlianHristov, received his MSc Degree from Medical University - Plovdiv, Faculty of Dental Medicine in 1996. He worked for 4 years as a General dentist. From 2000 he is an assistant-professor and from 2016 is a PhD-student in the Department of Prosthodontics, Faculty of Dental Medicine, Medical University,Plovdiv, Bulgaria. He is an active member of the: Bulgarian Dental Union (BDU), Bulgarian Scientific Dental Association, Balkan Scientific Society (BaSS). He speaks English and Russian fluently.
Faculty of Dental Medicine, Medical University, Plovdiv, Bulgaria.
3HristoBotevblvd., Plovdiv, Bulgaria