The Effect Of Surface Treatment And Thermocycling On Bond Strength Between Silicon Soft Denture Lining And Acrylic Resin Denture Base

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Abstract

Introduction: Silicon Soft Denture Liner (SDL) is often used along with heat polymerization acrylic resin (PMMA) as an obturator material because it can cover the undercut area in a broad defect for long term and painlessly. Despite that, silicon SDL and PMMA have different molecular structures so that they have a low bond strength. Long-term use can also affect the bond strength, so there is a need to increase the bond strength between PMMA and SDL. A method to increase the bond strength is surface treatment. This study is conducted to determine the effect of surface treatment and thermocycling on the bond strength of PMMA and Silicon SDL. Methods: The study used 40 samples (8 groups) divided into 4 groups based on the surface treatments, namely no surface treatment, sandblast, adhesive primer and combination, and further divided into two groups of thermocycling and without thermocycling treatment. The bond strength between PMMA and SDL was tested with tensile test by using Universal Testing Machine (UTM). Results: One-way ANOVA analysis showed there were significant differences of the bond strength among all groups (p <0.05) where the adhesive primer showed the highest value in all treatment groups. Conclusion: There is an effect of surface treatment and thermocycling on the bond strength between the PMMA and SDL, where the adhesive primer as a surface treatment material shows the highest bond strength of all.

Keywords: heat polymerization acrylic resin, silicon soft denture lining, surface treatment, bond strength.

1. Introduction

Silicon soft denture liner (SDL) has been very widely used as an enhancer of the definitive obturator retention and stabilization. Permanent and biocompatible liquid silicone for maxillary defect tissue.[1,2] However, because SDL material is a coating material, it cannot be used alone without the support of denture base which generally uses PMMA material. The PMMA material and the LTSDL Silicon material have a larger molecular structure thereby increasing complexity as the bond strength between the two.

Surface treatment is one of the efforts to increase the bond strength between LTSDL Silicon and PMMA base. There are 2 surface treatment methods that can be done to increase the adhesive strength between the two, the chemist and mechanical methods. One method of chemistry is to use Primary Adhesive. The mechanism of action of the Primary Adhesive is chemically by wetting the surface, dissolving the surface of the PMMA base and forming a smooth porosity so as to provide a mechanical bond between the LTSDL Silicon and the PMMA base. Sandblast as a mechanical method, when viewed from the application through SEM observations, shows a rougher surface and has greater mechanical interlocking so that it is considered to provide better mechanical bonding than Primary Adhesives.[3,4]

This study aims to determine the effect of surface treatment and thermocycling on the bond strength of LTSDL Silicon on the base of PMMA.
1.1 Soft Denture Lining (SDL)
Soft Denture Lining (SDL) according to ISO definition is a soft material that is most often used in prosthodontics as a soft coating material whose soft properties persist after polymerization.[5] This soft material is coated on the surface of the denture base facing the defect areas and other areas that have undercut.[6-9]

Functions and indications of soft denture lining including: [5,10-14]
1. Replace reduced mucoperiosteum thickness in patients with severe lateral resorption due to prolonged use of dentures
2. Overcoming complaints of pain and discomfort of patients using dentures whose base is made of hard and stiff acrylic resin, especially in patients who have defects, sharp and thin ridges, waist with undercut, thin mucosa and not resilient
3. Distribute the load or pressure evenly throughout the denture bearing area
4. Giving comfort to patients using dentures who have bruxism and xerostomia problems
5. Determine the temporary diagnosis of the cause of prolonged pain complaints from the patient
6. As a functional molding material to repair old denture bases while waiting for the making of new dentures
7. Reducing pressure on the mucosal area after tooth extraction and implant surgery
8. Increasing obturator retention and stabilization in patients with palate defects with the nature of the material that is able to enter the undercut area

The selection of the type of SDL that will be used is in accordance with the clinical condition of the patient and should meet the ideal nature of SDL, including high bond strength, stable dimensions, permanent soft nature, low water resorption, stable color, easy to manufacture and biocompatible. The durability of using SDL will be longer if it meets the ideal SDL requirements.[5,13,15]

SDL was used in dentistry more than a century ago by Twichell in 1869 in the form of soft natural rubber. In 1945, Tylman introduced SDL in the form of plasticized polyvinyl resin which was then continued with elastomer silicones introduced in 1958.[1,16,17]

ISO classifies the material Soft Denture Lining (SDL) into 2, namely: Short term / Long term and Long term. Short term SDL is SDL which is temporary or temporary. The material which is the Short Term SDL category is Tissue conditioner. Long term SDL is SDL which is definitive or permanent. LTSDL can be used in more than 4 weeks to several months, even up to several years. Long Term Soft Denture Lining (LTSDL) is grouped into two namely Plasticized acrylic resin and Silicone elastomer.[13] Other names based on ISO are LTSDL Acrylic (ALTSDL) and LTSDL Silicon (SLTSDL), each of which is further divided into two, namely autopolymerization (autocured or roomtemperature vulcanized (RTV) and heatpolymerization (heattreated or heat-temperature vulcanized (HTV)). Also referred to as chairside LTSDL because of its application that can be carried directly into the patient's mouth while the heatpolymerization of ALTSDL must go through a laboratory process. [5,11,16,18]

Long term SDL is a type of SDL that is often used for anatomic tissue conditions under the base of problematic dentures such as sharp and thin edges, heavy resorption and severe undercut. [11]

LTSDL Silicon Heatpolymerization is available in one paste with one adhesive (propyl trimethoxysilfan). The composition consists of Polymer Polydimethylsiloxanes with organic peroxide (benzoyl peroxide). Both of these materials will crosslink with free radicals produced by the decomposition of organic peroxide at high temperatures. [10-13]

Fig. 1. (A) Primo adhesive 03004, (B) Molloplast-B (silicone based heat cure soft liner) [16]

1.2 Bond Strength
There are many factors that affect the bond strength between denture base material and obturator bulb base, which can be derived from the nature of the SDL material itself or from environmental factors.

Aging factors are aging factors obtained during use such as changes in temperature when eating and drinking and absorption of water during immersion in water or denture cleanser. The aging factor of SDL can reduce the bond strength of...
SDL on PMMA denture base. The effect of aging is stronger on LTSDL Acrylic than LTSDL Silicon because Acrylic always releases plasticizers when in contact with saliva and is hydrophilic to absorb water during immersion. [19-21]

Thermocycling has more effect on LTSDL Acrylic than on LTSDL Silicon. Pinto, et al's research quoted from Xiaoping M, et al (2015) states that 4000 thermocycling can reduce the bond strength of LTSDL Acrylic but does not affect the bond strength of LTSDL silicon. Thermocycling can reduce the bond strength of LTSDL Silicon after 5000 thermocycling which is simulated after 5 years of LTSDL usage. Nonetheless, the bond strength values of LTSDL Silicon on the base of PMMA denture are still clinically acceptable. [1,4,5,22]

Colonization of Candida albicans itself is 31% the cause of failure of SDL attachment on PMMA denture base. The amount of colonization of candida albicans can reach 44% in 1 year and has the potential to cause attachment to break because the location of the highest colonization is at the edge of the meeting point of the silicone SDL with a denture PMMA base. Factors affecting the amount of colonization of Candida albicans and other microorganisms are the level of basic cleanliness and SDL, salivary state, the level of porosity of SDL material and the amount of plasticizer content in SDL. [5]

The thickness of the SDL also affects the bond strength. The recommended thickness is 2-3 mm so that the SDL can function as a cushioning effect and obtain adequate adhesion. If the layer is too thin then the SDL function will not be obtained, the patient still feels persistent pain, decreases softness whereas if SDL is too thick the base thickness will be reduced which will result in disruption of stability and fracture of the denture base. Optimal thickness cannot be obtained from the Autopolymerization type of LTSDL. This method can be done by an indirect technique using a type of Heatpolymerization of LTSDL. The thickness of the SDL can be more easily controlled by using spacers from wax, self-curing resins, putty silicones and vacuum formed. This indirect technique is best carried out by LTSDL Silicon Heatpolymerization rather than LTSDL Acrylic Heatpolymerization because it is not fast hardened and is already available in one paste so that it is easy to manipulate during application. Whereas SDL Acrylic heatpolymerization still requires mixing between monomers and polymers when they are applied and the nature of the material which is rapidly hardening. [5,14]

Other factors affecting bond strength are water absorption which is influenced by the amount of contents of the plasticizer and solvent, the hydrophobic level and porosity of the material and the duration of contact with saliva, water and denture cleanser. [1,5,13,23,24] High water absorption can reduce the bond strength of SDL due to the expansion of SDL volume which then results in an increase in the concentration of pressure at the boundary between the surface of the SDL and the PMMA base so that the attachment between the SDL and the PMMA base is detached. [1]

There is no difference in the effect of immersion in water or denture cleanser on the decrease in bond strength but the length of time immersion in water or denture cleanser that affects the level of adhesion strength of all types of SDL. [23,24] To prevent the decreased strength of SDL adhesion on the base of PMMA denture due to soaking by limiting the use of denture cleanser, using only flowing water or by soaking the enzymatic type of denture cleanser is recommended. [5] Immersion in the enzymatic denture cleanser when compared with immersion in water did not show a significant difference in adhesion strength of the four types of SDL to PMMA denture bases. The adhesive strength of Acrylic and Silicon LTSDL is equally strong within 24 hours of immersion in water and polydent. However, after 6 months of immersion, LTSDL Acrylic showed the worst adhesion strength while the adhesion strength of all LTSDL Silicon was still clinically acceptable. [1]

The type of base used affects the SDL stickiness. [1,11] Mollosil which is the Autopolymerization of Silicon LTSDL has the highest adhesion strength on the PMMA denture base than the UDMA denture base. [25] The bond strength of Heat and Autopolymerization of LTSDL is stronger on the base of PMMA which is polymerized by conventional techniques in water baths than using microwaves. [26]
Bond strength is assessed in MegaPascal (MPa) by dividing the value of the maximum tensile strength until the attachment failure (F) is assessed in Newton by the cross-sectional area (A) which is assessed in mm².

This test has undergone ISO 10139-2: 2016 and ASTM E8 standardization in America. SDL is still clinically acceptable if the adhesive strength is 10 pounds per inch or 4.5 kg / cm² = 0.45 MPa. This value indicates the threshold for SDL edge separation to denture base. [2,5,16,17]

1.3 Surface Treatment

Surface treatment is the treatment of the surface of an object so as to produce changes in the morphological shape and physical changes in the material.[27] In this case, the surface treatment carried out results in a rough PMMA base surface. According to his theory, a rough surface can provide twice the adhesive strength than a smooth surface.[4,12]

There are 3 methods of surface treatment carried out by some researchers on LTSDL Acrylic and LTSDL Silicon materials, namely chemist, mechanical and combination methods. The chemist method is to surface the surface by applying a chemical solution to the surface interface of the PMMA denture base before applying SDL.[2,9,28-31] This method is safe and easy to do.[32] Chemical solutions applied to the PMMA-SDL base interface are adhesive primary solutions or bonding agents.[28,29] MMA and Acetone[25] Ethyl acetate (OH) [30] 36% phosphoric acid [33] Methylene Chloride[9,31,34] and Silane coupling agents.[35] The study of Cavalcanti, et al (2014) [36] shows that MMA monomers produce the highest adhesion strength than Acetone and Ethyl acetate materials. However, MMA monomers have low ability to dissolve the PMMA base so that it is still difficult to penetrate in.[37] While adhesive primers are generally intended for factories for LTSDL silicon material in an effort to assist their attachment on the base of PMMA,[5,29,38]

An adhesive primer is an organic solution that dissolves the base surface so that the PMMA base surface substrate becomes more moist and homogeneous, forms a microporosity gap, improves cleanliness and, dissolves particles that are not bound to the base surface of the PMMA denture so as to facilitate the attachment of Silicon LTSDL to the base surface.[29,39]

The adhesive primary composition consists of solvent (99.5%) and agent (0.5%). This adhesive primer is a reactive free molecule, namely the organic solution of Poliorganosiloxane. Examples are Molloplast adhesive and Mollosil adhesive. The ability of the Primary Adhesives to increase the bond strength of LTSDL can be seen from SEM observations which show the morphological changes in the surface of the PMMA base after the application of the Primary adhesives are becoming coarser and the formation of micoretention [28]

Mechanical method is the method of marketing the surface of the denture base interface by using a mechanical device before applying SDL. Sandblast in this case is one method of increasing the bond strength between SDL and PMMA bases. Sandblast was originally a routine application for general industry in an effort to increase the stickiness of materials. Many variations of application, such as in procedures for repairing ceramic and composite materials, attaching indirect composites, attaching fiber posts from glass, attaching SDL to PMMA, for the initial treatment of metal surfaces in metal-ceramic restorations, or as part of the tribochemical silica-coating process.

The Sandblast abrasive procedure will be able to lift the contaminated layer and its rough surface will form a mechanical interlocking or binding lock that can bind SDL with different degrees of variation depending on the area of surface roughness.[32] The method is by spraying aluminum oxide (Al2O3) particles with high pressure to the surface of the PMMA base that will contact the SDL. Sandblast systems generally use alumina particles of various sizes ranging from 30 to 250 μm [32,39] This method will make the base surface irregular so that mechanical interlocking is formed which can help the attachment between two different material surfaces Mechanical methods can be carried out using sand paper [23,41] acrylic bur, oxygen plasma, silica, laser [28,35] and sandblast with alumina particles. [4,30,32]

The chemo-mechanical method is a surface treatment method that combines the use of mechanical devices and chemical solutions. The research of Philip, et al (2012) [43] combines mechanical and chemist methods by spraying alumina particles using a Sandblast tool for 5 minutes then continuing with the application of monomers that produce the highest adhesion strength. But the research of Kulkarni, et al. (2011) said that only with a monomer the bond strength between LTSDL and PMMA base would increase effectively without the need for sandblasting.[9]

2. Material and Methods
This type of research is a laboratory experimental study with a post test only control group design research design. The study was conducted in three places, namely: USU FKG Dental Laboratory TEST Unit, USU FKG IMT Laboratory and FKG Biomaterial Research Laboratory Universiti Malaya.

The study was conducted in March - August 2019. The sample in this study used the Acrylic Heat Polymerization (QC-20) material and the SDL (Molloplast B) Silicon Heatpolymerization material. SDL material was applied on the PMMA base without surface treatment as a control and with surface treatment. There are 5 treatment groups based on surface treatment (without surface treatment, sandblast, adhesive primer and sandblast-primer adhesive combination). Determination of the minimum sample size is based on the following formula: (Hanafiah KA., 2003) \((t - 1) (r - 1) > 15\). In this study there are two sample groups with 5 treatments, then \(t = 8\), so the total number of samples for 5 groups were 40 samples.

The independent variables in this study are the surface treatment method and Thermocycling. While the Bound Variable in this study is the close strength of PMMA with SDL. The surface treatment methods studied were sandblast, adhesive primer, and a combination of sandblast and adhesive primer. The main tools used in this study are sandblasting machines and thermocycling units. The tool used for bond strength testing is Universal Testing Machine (Tensilon, Japan). The material used in this study consisted of Dental Stone (Moldano, Herausz Kulzer, USA), Hot polymerization acrylic resin (QC-20, Dentsply, England), Silicone Carbide sand paper 240, 400, 600 and 800 grit, Heatpolymerization of SDL Silicon (SDL) Molloplast B, Detax GmbH, Ettlingen, Germany), Mollosil Primer Adhesives (Mollosil primers, Detax GmbH, Ettlingen, Germany), 250 μm alumina sandblast particle granules, Clear plastic, vaseline and cold mold seals, Aquadest, distilled water.

The procedure of this research begins with the stage of planting the master model into a cuvette to make molds. Then the mold is filled with heat polymerization acrylic resin as an obturator base material. PMMA samples were 40 samples. For groups without Surface Treatment (A): The PMMA base is cleaned, dried and put into mold. Apply SDL to the center of the mold lid and press. After polymerization, the sample is removed. For Sandblast group (B): Same procedure as group A, additional procedure: Spray 250 μm alumina particles within a distance of 10 mm and a time of 10 seconds on the surface of the PMMA base interface. For the Adhesive Primary (C) group: Procedure is the same as for Group A, additional procedure: Apply the adhesive primer 1-2 times on the surface of the PMMA base interface. For Sandblast and Primary Adhesives (D) groups: The procedure is the same as group A, an additional procedure is a combination of surface treatment B and C. The sample is then immersed in distilled water. Then the adhesive strength was tested by Tensile test using UTM tools. Analysis of the data used for this study is Univariate Analysis to determine the average value and standard deviation of each group. Then a one-way ANOVA test was performed to determine the effect of Surface Treatment and Thermocycling on the adhesive strength of silicon soft denture lining and hot acrylic polymerization resins.

![Fig. 3. The form of the sample test for the bond strength of SDL material.](image)

![Fig. 4. Before and after the Integration of PMMA Bases with LTSDL Silicon](image)
3. Results

To determine the effect of surface treatment on the adhesion strength of heatpolymerized Silicon SDL-PMMA bases, the sample data were analyzed using the One Way Anova test. Before the One Way Anova test is performed, it is first known whether the sample data is normally distributed or not with the Saphiro-Wilk test (n<50). From the Saphiro-Wilk test, significance values (p) were obtained for all types of surface treatment in the SDL-PMMA base heatpolymerized silicon sample group tested between 0.043 to 0.873 which means that the data were normally distributed (p> 0.05). From the results of the Saphiro-Wilk test which states that the data are normally distributed (p> 0.05), it means that the data can be continued with the One Way Anova test. Based on the One Way Anova test results obtained a significant influence of surface treatment sandblast, adhesive
primer, and sandblast-adhesive primer on the adhesion strength of heatpolymerized Silicon SDL-PMMA base with $p = 0.0001$ ($p < 0.05$) (Table 1)

**Table 1. Effect of surface treatments on the bond strength of Silicon SDL-PMMA base in the non thermocycling group.**

<table>
<thead>
<tr>
<th>Surface Treatment Types</th>
<th>Number of Samples</th>
<th>Bond Strength (MPa)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Surface Treatment</td>
<td>5</td>
<td>1.098±0.078</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Primer Adhesive</td>
<td>5</td>
<td>1.370±0.092</td>
<td></td>
</tr>
<tr>
<td>Sandblast</td>
<td>5</td>
<td>2.115±0.330</td>
<td></td>
</tr>
<tr>
<td>Sandblast+Primer Adhesive</td>
<td>5</td>
<td>1.754±0.079</td>
<td></td>
</tr>
</tbody>
</table>

* significant ($p < 0.05$)

**Table 2. Effect of surface treatments on the bond strength of Silicon SDL-PMMA base in the thermocycling group.**

<table>
<thead>
<tr>
<th>Surface Treatment Types</th>
<th>Number of Samples</th>
<th>Bond Strength (MPa)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Surface Treatment</td>
<td>5</td>
<td>1.204±0.010</td>
<td>0.716</td>
</tr>
<tr>
<td>Primer Adhesive</td>
<td>5</td>
<td>1.319±0.056</td>
<td></td>
</tr>
<tr>
<td>Sandblast</td>
<td>5</td>
<td>1.265±0.023</td>
<td></td>
</tr>
<tr>
<td>Sandblast+Primer Adhesive</td>
<td>5</td>
<td>1.244±0.015</td>
<td></td>
</tr>
</tbody>
</table>

* significant ($p < 0.05$)

**Table 3. Effect of thermocycling on the bond strength of Silicon SDL-PMMA base.**

4. Discussion

The composition of Heatpolymerized SDL silicon consists of Polydimethylsiloxanes polymer with organic peroxide (benzoyl peroxide). Both of these materials will crosslink with free radicals produced by the decomposition of organic peroxide at high temperatures. Table 1 shows the results of the analysis by the One Way Anova test which states that there is a significant influence of surface treatment sandblast, adhesive primer and adhesive sandblast primer on the significant increase in adhesion strength of heatpolymerized silicon SDL-PMMA base with a significant value of $p = 0.0001$ ($p < 0.05$). The surface treatment of sandblast, adhesive primer and adhesive sandblast-primer combination influences the adhesiveness of heatpolymerized
silicon SDL-PMMA base. Surface treatment of adhesive primers has the most significant and significant effect on the increased strength of the SDP-PMMA base heatpolymerized silicon adhesives than other surface treatments. The results of this study are in line with the research of Korkmaz et al. (2013) which states that adhesive primers are very good at increasing the adhesion strength of heatpolymerized silicon SDL-PMMA base. The effect of surface treatment in increasing the adhesive strength of heatpolymerized silicon SDL-PMMA base can be observed through SEM images. The results of SEM images show that there are differences in the surface morphology of PMMA bases that are not surface treated and those that are surface treatment sandblasts, adhesive primary molloplasts and combined adhesive primary sandblasts. PMMA base surfaces that are not surface treated reveal a smooth PMMA base surface with regular horizontal parallel strokes. This illustration shows the absence of mechanical retention in the form of surface roughness of the PMMA base which can help increase the bond strength of heatpolymerized SDL silicon. Nonetheless, the adhesion strength of heatpolymerized silicon SDL on an PMMA base that is not surface treated is sufficiently well proven by its average value which is above the standard.

This is because heatpolymerized silicon SDL contains polydimethylsiloxane polymer with organic peroxide (benzoyl peroxide) where both of these materials will crosslink with free radicals produced by decomposition of organic peroxide material at high temperatures so that it can help in increasing its bond strength. PMMA base surfaces in sandblasts produce rough, sharp and irregular surfaces with shallow, angular surface cracks which are some of the gaps covered by large sized alumina particles, 250 μm. However, this does not become an obstacle for heatpolymerized silicon SDL to penetrate and form mechanical interlocking due to the high temperature curing process using a waterbath so as to make the remaining alumina particles settling in the surface gap of the PMMA base easily dissolve. The results of this study indicate that there is a significant influence of surface treatment of 250 μm alumina sandblast particles on the significantly increased adhesive strength of heatpolymerized SDL-base silicon PMMA. These results are in line with the research of Usumez et al. (2004) and Akin H, et al (2011) but contrary to the research of Kulkarni RS, et al (2011) which mentions that sandblast 250 μm alumina particles weaken the bond strength of PMMA-heatpolymerized silicon SDL bases. The PMMA base surface given an adhesive primary molloplast surface treatment produces a rough surface such as a trabeaculae with many clear, large pores, which are spread evenly and interconnected. This figure shows the influence of adhesive primary molloplast surface treatment in increasing the adhesion strength of heatpolymerized silicon SDL-PMMA base. Primary adhesive molloplast is a combination of derivative ethoxy and methoxy silane (methacryloxypropyltrimethoxysilane) or as a silane coupling agent. Silane coupling agents are silicon-based chemical additives consisting of two reactive types (inorganic and organic). The general structure is (RO) 3 SiCH2CH2CH2-X, where RO is a hydrolyzed group such as methoxy, ethoxy or acethoxy and X is an organofunctional group such as amino, metacryloxy, epoxy and others.

The content of the Silane coupling agent works at the interface between the inorganic part and the organic material to bind or combine the two unequal materials. This material soaks the entire PMMA base surface and makes the base surface hydrophilic. The hydrophilic base surface will decrease the contact angle and surface tension so that it can absorb the silane solution. The absorbed silane solution then dissolves the PMMA base surface and forms a pore that facilitates heatpolymerized silicon SDL to penetrate and form mechanical interlocking. One factor that affects bonding is the transfer of water to the hydrophilic surface. Water entering the interfaces of both substances can damage the bond between the polymer and SDL but a coupling agent is able to change the hydrophilic surface to hydrophobic so that it can prevent the absorption of water entering the bond between the PMMA and SDL bases so that the bond strength of the SDP-base silicon heatpolymerized becomes best.

The results of this study are the same as those of Korkmaz et al. (2013) which stated that adhesive surface treatment primers were effective in increasing the adhesion strength of PMMA-based SDP heat-polymerized silicon. PMMA base surfaces in adhesive primary sandblast-molloplast not only produce rough surfaces but also produce interconnected large sizes of porosity that are not produced through other surface treatments. This figure shows the influence of adhesive primer sandblast-molloplast surface treatment in increasing the adhesiveness of heatpolymerized silicon SDL-PMMA base. However, the value of the adhesive strength obtained is not better than if only using an adhesive primary molloplast surface treatment only. This may be due to the presence of alumina particles that cover the surface gap, thereby reducing the number and pore size of the PMMA base surface formed by adhesive primary molloplast solutions. The remaining alumina particles cannot dissolve through the heating process after the adhesive primary molloplast surface treatment is due to the presence of a coupling agent that changes the surface of the previously hydrophilic PMMA base to hydrophobic thus preventing water absorption. This is likely the cause of the adhesive primary sandblast-mollosil combined surface treatment does not have a better effect than if only the adhesive primary molloplast is used.
Table 2 shows that there was no significant effect between without surface treatment, with surface treatment sandblast, with adhesive sandblast surface treatment and with adhesive sandblast-primer combined sandblast surface treatment on the adhesive strength of the SDP-PMMA base heatpolymerized silicone adhered after thermocycling (p > 0.05). The highest adhesive strength value accompanied by cohesive failure was found in the primary adhesive surface treatment group, indicating that this method was the most effective way to increase the adhesive strength of heatpolymerized silicon SDL than sandblast and combined adhesive sandblast-primary molloplast. The adhesive primer used by heatpolymerized silicon SDL is derived from trimethyloxilane organic polymer material which in addition to producing a rough surface also produces interconnected large size porosity which is not produced through other surface treatments. PMMA base surfaces that have been surface treated with adhesive primary mollosils produce rough and porous surfaces measuring 120.8 μm x 50,900 to 4,143 μm x 303.50. The PMMA base surface that has been treated with an adhesive primary molloplast that has a SDP heatpolymerized silicone material produces a rough surface and larger porosity of 3,680 μm x 80.80 to 4,748 μm x 346.20. The pores formed in the primary adhesive mollosil are not joined together while the pores formed in the adhesive primary molloplast are interconnected. Porosity is a factor that affects the physical interactions and chemical reactions of solids and gases or liquids. Porosity is a value used to describe how many vacancies, or voids, spaces / gaps exist in a sample. The more space or voids, the easier an SDL silicon material to penetrate and form mechanical interlocking on a PMMA base. However, in conditions of long-term use (which is simulated by thermocycling) all surface treatments show almost the same adhesion (not significantly different).

Table 3 shows there is significant effect of thermocycling in bond strength of PMMA base and SDL Silicon for all surface treatments group. The effect of water on the adhesive properties of the resilient lining material to denture base material is of utmost importance in final clinical success. After thermocycling, all materials showed a significant reduction in bond strength. The reduction in the bond strength is the result of swelling and stress buildup at the bond interface or of the changed viscoelastic properties of the resilient denture lining materials.

5. Conclusion

From the limitation of the study, it is concluded that there is an effect of surface treatment on the bond strength between heatpolymerized Silicone SDL and PMMA denture base resin without thermocycling, while there is no effect if done with thermocycling. There is also an effect of thermocycling on the bond strength between heatpolymerized Silicone SDL and PMMA denture base resin in different surface treatments. After 1000 cycles of thermocycling (simulating 1 year use), Silicon SDL still showed satisfactory bond strength with or without surface treatments (above 0.4 Mpa). Primer adhesive is the most effective surface treatment to increase the bond strength.

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