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EFFECT OF SURFACE TREATMENT TO BOND STRENGTH OF SILICONE SOFT DENTURE LINING TO HEATCURED ACRYLIC RESIN DENTURE BASE

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ABSTRACT--*Silicone soft denture lining (SDL) material as a part of SDL is defined by ISO as a soft resilient material bonded to the fitting surface of the denture to reduce trauma to the supporting tissue. Silicone SDL nowdays have been famous as an obturator bulb of heatcured acrylic resin (PMMA) denture base because of soft permanently and biocompatibility properties which can be used to add the retention and stability of definitive obturator for patient with severe undercut palatal defect without giving the painfull. The only weakness of silicone SDL is bond failure to PMMA that make microleakage created an environment for potential bacterial growth. Bond failure can be solved by surface treatment. Purpose : The aim of this study were to evaluate the effects of 3 different surface treatments (sandblasting, primer adhesive and sandblasting-primer adhesive combination) on bond strength of 2 kinds of silicone SDL (autopolymerized silicone SDL and heatpolymerized silicone SDL) to PMMA denture base. Methods : The 3 mm thickness of silicone SDL were processed between 2 PMMA blocks became one specimens (n=40). The bond strength of 40 specimen of PMMA-Silicone SDL were measured by tensile test with universal testing machine at a crosshead speed of 5 mm/min until failure was detected. The bond strength (MPa) was calculated by dividing the maximum tensile strength value with cross-sectional area. T-test, ANOVA and LSD tests were used to analyze the data (α=0.05). The bond strength value were analyzed with types of failure (adhesive, cohesive and mixed failure) and morphology view of PMMA surface by a single operator. Result : PMMA-heatpolymerized silicone SDL with or without surface treatment were the higher significance bond strength than PMMA-autopolymerized silicone with or without surface treatment. All of the surface treatment can be increase the bond strength either to PMMA-autopolymerized Silicone SDL or to PMMA-heatpolymerized Silicone SDL. The significance effect of surface treatment is Primer adhesive either to PMMA-autopolymerized silicone SDL or to PMMA-heatpolymerized silicone SDL. Conclusion Primer adhesive gave the highest significance effect to PMMA-heatpolymerized silicone SDL characterized either with highest bond strength values, cohesive failures and highest roughened surfaces of PMMA interface.*

Keywords--*surface treatment, bond strength, silicone soft denture lining (Silicone SDL), heatcured acrylic denture base (PMMA)*

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I. INTRODUCTION

Soft denture lining materials (SDL) is a dental prosthetic treatment material which maintain soft after polymerization (1). It is applied to the fitting surface of the denture in order to provide comfort for patients who cannot tolerate occlusal pressures, to give more equal force distribution, and to improve denture retention by engaging undercuts (2, 3, 4). SDL when used together with hard denture base resin provided the advantage of cushioning effect without decreasing the masticatory efficiency (4). In a 6-year retrospective study, 93% of edentulous patients felt more comfortable when the denture was lined with a soft liner (5).

The favorable properties of SDL are; long-term resiliency and good bond strength to denture base material (3,6). There are two types of SDL materials namely temporary soft denture lining material or Tissue conditioner, and permanent soft denture lining materials : acrylic SDL and silicone SDL materials which both of them are divided into autopolymerized and heatpolmerized (3, 7, 8). Autopolymerized soft lining materials allow the dentist to reline a removable denture directly in the mouth. This method is faster than heatpolymerized (laboratory-processed) system and the patient is not without the prosthesis during the time required for the laboratory procedures (9, 10).

Tissue conditioners are soft, resilient materials whose function is for very short duration generally a matter of few days (1). Acrylic soft denture lining materials are long term soft denture lining, up to 6 month and Silicone soft denture lining materials are long term soft denture lining, up to 1 years (8). Tissue conditioner and acrylic soft denture lining have plasticizer content to make it soft but plasticizer can leachable easily to saliva and water then absorbs the water to replace it till make acrylic soft denture lining is loss of softness, hardening with time and changing the bond strength properties (3, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17). Tissue Conditioner exhibited the highest cytotoxic effect at all incubation periods such as burning sensation in the mouth or red, swollen and painful gums. Sometimes, even oral vesicles and ulcers were formed. It must be used with caution as it exhibited high cytotoxic potency to induce allergic reactions (18). Plasticizer contained phthalate may cause hormonal disorders, reproductive toxicity, hepatocellular tumours, genital disorders owing to a capacity to bind estrogen receptors, and a low-dose toxic action during certain periods of fetal development (12). While silicone SDL consist of dimethyl siloxane polymer and have no plasticizer to make it soft, the softness come from an intrinsic property of this type of polymer (elastomer) ; therefore they retain their resilience for longer periods. (1, 3, 6, 7, 8, 19).Beside that, silicone SDL is good biocompatibility at all incubation periods, indicating that they were safe for clinical use (18).

Silicone SDL is available in two kinds. It is as base-catalyst that cross-link at room temperature called autopolymerized SDL e.gMollosil andin one-paste that cross-link at high temperatures called heatpolymerized SDL e.gMolloplast B. Mollosil consist of An adhesive for Mollosil is polymethylmethacrylate with polyorganosiloxane with ethyl acetate 60-100 %. Molloplast B consists of a polymer (polydimethylsiloxane), cross-linking agent (acryloxy alkylsilane), and catalyst (heat and benzoyl peroxide). An adhesive for Molloplast B is Y-methacryloxy propyl trimethoxysilane. It is a silicone polymer in is supplied as a solvent to aid bonding to the denture base (20).

Autopolymerized and heatpolymerized SDL materialnowdays have been famous used as an obturator bulb ofheatcured acrylic resin denture base for patient with severe undercut palatal defect without giving the painfull because of soft permanently and biocompatibility properties (21). Heatpolymerized silicone SDL can be retain the softness until 3-6 years (3). Engagement of soft tissue undercuts of edentulous patient with palatal defect by using Silicone SDL have giving more retention and stabilization for the definitive obturator. The weight of obturator bulb on large size of palatal defect can be lighter by hollow core design of PMMA denture base (12). Heatpolymerized SDL has excellent shock absorber property which is directly related to the thickness of the layer of the liner.20% reduction in force for 0.25 mm thick silicone soft liner layer which was further reduced to 60% for the thickness of 4 mm silicone layer (20).

However, silicone soft denture lining haveweak bond strength to heatcured acrylic resin denture base during clinical use because of their different microstructure so they cannot be chemically bonded. Bond failure makes microleakagethat can create an environment for potential bacterial growth, plaque and calculus formation thus accelerated breakdown of the soft lining material (3, 4, 6, 7, 8, 9, 11, 22, 23, 24, 25). Sufficient bond strength between silicon SDL and PMMA intaglio surfaces is required to avoid interfacial separation at the denture borders (3).One method has often been conductedto increase bond strength by many researcher is surface treatment the intaglio of PMMA surfaces before application the SDL (9, 26).Surface treatment resulted the roughened surface of PMMA and it will be increase bond strength double dose than smoothened surface (14).

There are 3 methods of surface treatment; mechanical (laser, sandblasting, sandpaper, acrylic burs), chemical (primer adhesive, MMA, acetone) and combined both of them. This study used sandblasting as mechanical technique, primer adhesive as chemical technique and sandblasting-primer adhesive as combined both of them. Sandblasting resulted a roughened surface that can be removes loose contaminated layers and some degree of mechanical interlocking or 'keying' with adhesive (14, 24, 27). Sandblasting has been used toa variety of applications, such as in ceramic, and composite repair procedures, indirect composite bonding, bonding of glass fiber post, polymethyl methacrylate (PMMA)-soft denture liner bonding (9). Sandblasting procedure can be applied either at the laboratory or chairside, relatively safe and easy means of roughening the surface of materials. It involves spraying a stream of aluminum oxide particles (using large or small size particles ranging from 30 to 250 µm) against the material surface intended for bonding under high pressure resulted mechanical retention (3, 9, 28).

Primer adhesive was fabricated by manufacturer to silicon SDL which can be utilize the mechanical interlocking silicone SDL to PMMA surface. Primer adhesive havesilicone-based soft liner and solvents (99.5%) and agents of union (0.5%) in its composition. The solvents increase the surface wettability, promote the cleaning of the surface, and dissolve unattached particles of PMMA acrylic resin surface (16, 29). Organic solvent such as methyl methacrylate (MMA) monomer, acetone (AC), ethyl acetate (EA), methylene chloride, can soften the surface and improve silicone SDL penetration (22, 26, 30, 31). The surface softening and porous topography observed for the MMA and EA treatments may improve adhesive penetration and mechanical interlocking (26). While the chemical composition of the bonding agents and the relining materials and their combinations affected the depth of the swollen layers of the denture base polymers and the tensile strength of adhesion (29, 32). Primer adhesive for heatpolymerized silicone SDL (molloplast B primer adhesive) has 3-methacryloyloxypropyltrimethoxysilane in both the primer and the paste itself, which aids bonding to PMMA via the methacrylate groups of the organo-silane in addition to its function as a cross-linker (29).

Several study said that the bond strength of PMMA-autopolymerized silicone soft denture lining can be increase by primer adhesive (4,10,26) while the bond strength of PMMA-heatpolymerized silicone SDL can be increase by sandblasting (9, 14, 28). Atsu S and Keskin Y said that bond strength of PMMA-autopolymerized silicone SDL can be increase by primer adhesive than sandblasting 50 μm (10). Korkmaz, et al (2010) said that PMMA-heatpolymerized silicone SDL can be increase by primer adhesive and decrease by sandblasting 50 μm (31). Akin H, et al (2011) showed that sandblasting alumina 50 μm has decrease the bond strength of PMMA-heatpolymerized silicone SDLwhile 120 μm and 250 μm have increase the bond strength of PMMA-heatpolymerized silicone SDL (9). Nakhaei M, et al(2016) advocated that sandblasting alumina 110 μm can increase the bond strength of PMMA-heatpolymerized silicone SDL (14). Usumez, et al (2004) showed that sandblasting alumina 250 μm can increase the bond strength of PMMA-heatpolymerized silicone SDL (28).It was assumed that the smaller size of irregularities created by the alumina particle may be insufficient to allow flow of the silicon SDL into them (3). The larger size of alumina particle will increase surface roughness too by created a larger pits and depression in larger surface area thereby the silicon SDL could penetrate into them and bonding more easily (14). But there was contradiction result of the investigation byKulkarni RS, et alwhich said that sandblasting alumina 250 μm has decrease bond strength PMMA-heatpolymerized silicone SDL (23). Philip et al showed that combined sandblasting 50 μm with monomer as the chemical technique surface treatment was giving the highest bond strength of SDL. Thereforethis study were to reinvestigate the effects of sandblasting 250 μm particle size and to compare sandblasting 250 μm with primer adhesive and sandblast-primer adhesive combination in order to evaluate the bond strength of two kinds of silicone SDL, the significance effect and difference effect of 3 methods surface treatment that can increase the bond strength of PMMA-autopolymerized silicone SDL and PMMA-heatpolymerized silicone SDL.

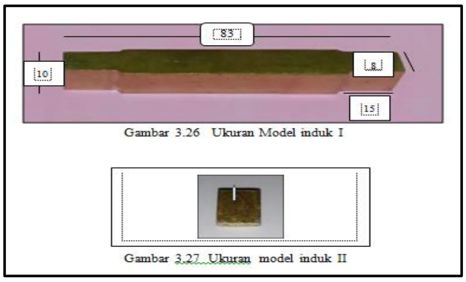
Measurement of bond strength can be done with 3 types: tensile test, peel test and shear test. Tensile test become the choice because it is widely accepted for scientific investigations and recommended by ASTM 2008 and ISO standard 2009. The result of tensile test was adhesive, cohesive and mixed failure, not always cohesive failure like peel test and exhibited not only tensile force but also shear force (7). In shear force, the concentration of forces is at the margin of the bond then caused failure earlier (6, 7). Tensile test was performed because it gives information on strength of bond in comparison to tensile strength of the materials and also because tensile properties are regarded as a general guide to the quality of rubbers (23). Tensile properties are regarded as a general guide to the quality of the rubbers, like silicone. Silicone soft denture lining with 0,44MPabond strength as minimal limit value are acceptable for clinical use (14, 15, 26). Then, bond strength value correlated with the type of failure (adhesive, cohesive, or mixed) and morphology view of PMMA surface. Effective surface treatment can be characterized by either high bond strength values, cohesive failures of PMMA-silicone SDL and high roughened surfaces of PMMA interface.

II. MATERIALS AND METHODS

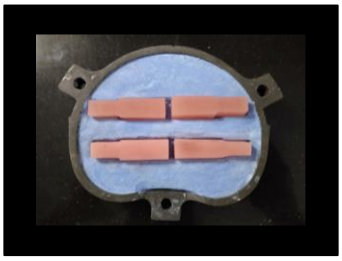
This study was using heatcured acrylic resin denture base (PMMA, QC-20, Dentsply, England), 2 kinds of silicone soft denture lining (SDL) :autopolymerized silicone SDL (Mollosil, Detax GmbH, Ettlingen, Germany) and heatpolymerized silicone SDL (Molloplast B, Detax GmbH, Ettlingen, Germany), 3 kinds of surface treatment : sandblasting(250 μm particle size), primer adhesive (mollosil primer adhesive and molloplast primer adhesive) and sandblasting-primeradhesive combination. A total of 40 specimen of silicone SDL were prepared and devided into 2 groups: 20 specimens for mollosil (Group 1) and 20 specimens for molloplast B (Group 2). 20 specimens of each type silicone SDL were devided into 4 subgroups namely 5 specimens for control/no surface treatment (Subgroup 1), 5 specimens for sandblasting (Subgroup 2), 5 specimens for primer adhesive (Subgroup 3) and 5 specimens for sandblasting-primer adhesive combination (Subgroup 4).

Fabrication of Specimens

The dimensions of specimen were such that they could be produced in conventional denture flasks and gripped easily in the testing machine (31). All specimen were made into the same dimensions and design by using brass rectangular pattern 83x10x10 mm and brass spacer 3x10x10 mm (Figure 1a).The brass rectangular pattern was invested into the dental flask that filled by dental stone (Moldano, Herausz Kulzer, USA) to gain the mold for PMMA block. PMMA blocks were fabricated by packing polymer-monomer PMMA into the mold by filled 3 mm brass spacer in the middle of the mold. The PMMA block was packed in to the mold space and processed at 70^0C for 90 minute, followed by 100^0C for 30-60 minute. The brass spacer was in its place while processing. After curing, the flask was bench cooled. The surfaces of 80 PMMA blocks with 40x10x10 mm size were finished and polished on the rotary grinderby using water and 240grit silicone carbide paper. All PMMA blocks then cleaned with distilled water and dried with 3-way syringe for 10 minute to remove the surface impurities. 2 PMMA block (each block with size 40x10x10 mm) were invested again into the mold then filled the middle mold with silicone SDL (size 3x10x10 mm) resulted 1 specimen (Figure 1b).



(a)



(b)

Figure 1: PMMA block specimen with 3 mm space for silicone SDL

Surface Treatment

1. Subgroup 1: Control (no surface treatment)

5 specimens of PMMA blocks were not surface treatment before application Mollosil

2. Subgroup 2: Sandblasting surface treatment

5 specimens of interface PMMA blocks were sandblasted with 250 μm aluminum oxide particles which is sprayed in light contact for 10 seconds at 10 mm distance and dried with 3-way syringe before application Mollosil or Molloplast B

3. Subgroup 3: Primer adhesive surface treatment

a. Mollosil primer adhesive: 5 specimens of PMMA interface PMMA blocks were treated with 1-2 coating of mollosil primer adhesive and wait for 1 minute before application of the mollosil SDL b.Molloplast B primer adhesive : 5 specimens of interface PMMA blocks were treated with 1-2 coating of molloplast B primer adhesive and wait for 1 hour before application of the molloplast B SDL

4. Subgroup 4: Sandblasting-Mollosil Primer adhesive combination surface treatment

a. Mollosil primer adhesive: 5 specimens of interface PMMA blocks were sandblasted with 250 μm aluminum oxide particles which is sprayed in light contact for 10 seconds at 10 mm distance and dried with 3-way syringe. Then treated with 1-2 coating of mollosil primer adhesive and wait for 1 minute before application Mollosil

b. Molloplast B primer adhesive: 5 specimens of interface PMMA blocks were sandblasted with 250 μm aluminum oxide particles which is sprayed in light contact for 10 seconds at 10 mm distance and dried with 3-way syringe. Then treated with 1-2 coating of molloplast B primer adhesive and wait for 1 hour before application of the molloplast B SDL

III. PACKING OF SDL

Group 1 (Mollosil SDL)

After surface treatment, equal lengths of base and catalyst of soft liner was mixed for 30 s. Lining the interface of PMMA blocks with Mollosil was done after removing the brass spacer, close the dental flask with cellophane sheet and press for 10-15 minute with 100-200 kvp till polymerize. After polymerization, all the specimens were retrievedand excess liner was cut using sharp scalpel. Thus the final specimens were obtained with mollosil in the middle of 2 PMMA blocks. The 20 specimens were stored in destilledwater at 37^0C for 24 h before testing.

Group 2 (Molloplast SDL)

After surface treatment, 10 g of Molloplast-B was packed in the space formed by removal of spacer. It was then bench-pressed for 10-15 minutes at 100–200 kvp. Polymerization was again done by placing the flask in cold water and heating slowly up to 100°C and further keeping it at 100°C for approximately 2 hours. Cooling of flask was done slowly. After polymerization, all the specimens were retrieved and excess liner was cut using sharp scalpel. Thus the final specimens were obtained with molloplast B in the middle of 2 PMMA blocks. The 40 specimens were stored in destilledwater at 37^0C for 24 h before testing.

Tensile test the specimen

The bond strength of each specimen was measured by devided the maximum value of stress at the time of failure (Kgf) with the surface area of adhesion (mm^2) by using universal testing machine (Tensilometer, AND, RTF – 1350, Japan) with one end of acrylic specimen attached to upper clamp and other end of acrylic specimen to the lower clamp.The specimen was pulled by clamp in opposingdirections with a crosshead speed of 5 mm/minute until failure occurred (Figure 3).

Figure 2: Tensile test PMMA-Silicone SDL specimen with UTM (Tensilometer, AND, RTF – 1350, Japan)

Failure Mode Observation

The mode of failure type (adhesive, cohesive and mixed failure) was determined by visual. Adhesive failure refers to total separation at the interface between the resilient liner material and acrylic resin, cohesive failure refers to tear within the resilient liner material, and mixed failure refers to both (Figure 4).

Figure 3: Failure mode evaluation of 40 specimen

Statistical analysis

The result was analyzed with t-test, one-way analysis of variance (ANOVA) test and LSD test. Then, it correlated to morphology view of PMMA surface with and without surface treatment by using Scanning Electron Microscope (SEM Carl Zeiss EVO MA10, Japan) at 3500 x magnification.

IV. RESULT

Table 1: Result of Tensile test PMMA-autopolymerized silicone SDL and PMMA-heatpolymerized silicone SDL

Group	Material	n	Bond strength (X±SD) (MPa)	p-value	Tipe *Failure*

Kontrol	Autopolymerized Silicone SDL (Mollosil)	5	0.150±0,028	0.0001 *	5 AF
	Heatpolymerized Silicone SDL (Molloplast B)	5	1.098±0.078		5 AF
Sandblasting	Autopolymerized Silicone SDL (Mollosil)	5	0.396 ±0.063	0.0001 *	5 AF
	Heatpolymerized Silicone SDL (Molloplast B)	5	1.370±0.092		3 AF, 2 MF
Primer Adhesive	Autopolymerized Silicone SDL (Mollosil)	5	0.815±0.053	0.0001 *	5 AF
	Heatpolymerized Silicone SDL (Molloplast B)	5	2.115±0.330		5 CF
Sandblast + Primer Adhesive	Autopolymerized Silicone SDL (Mollosil)	5	0.591±0.112	0.0001 *	5 AF
	Heatpolymerized Silicone SDL (Molloplast B)	5	1.754±0.079		2 CF, 3 MF

T-test

The difference of bond strength between PMMA-autopolymerized silicone SDL and PMMA-heatpolymerized silicone SDL by t-test resulted that PMMA-heatpolymerized silicone SDL with or without surface treatment were the higher significance bond strength than PMMA-autopolymerized silicone with or without surface treatment.

One Way ANOVA Test

The effect of 3 kinds of surface treatment by one-way ANOVA showed that all of the surface treatment can increase either the bond strength of PMMA-autopolymerized silicone SDLor the bond strength of PMMA-heatpolymerized silicone SDL. The most effective of surface treatment is Primer adhesive.

LSD Test

Each of surface treatment have significance difference effect with other surface treatment through bond strength of PMMA-autopolymerized silicone SDLand PMMA-heatpolymerized silicone SDL.

V. FAILURE ANALYSIS

Adhesive failuremeans that tensile strength of the soft liner was greater than its bond strength to PMMA.Cohesive failures means that tensile strength of the soft liner was less than its bond strength to PMMA. Mixed failure indicating that the bond strength of the liner was nearly equal to the tensile strength of the liner (23).

Adhesive failure was dominated by all specimen of PMMA-autopolymerized silicone SDL with all surface treatment group and without surface treatment (control) group. Adhesive failure was also occurred in all specimen of PMMA-heatpolymerized silicone SDL without surface treatment (control) group and 60 % specimen of PMMA-heatpolymerized silicone SDL with sandblasting group.

Cohesive failure was dominated by all specimen of PMMA-heatpolymerized silicone SDL with primer adhesive group and 40% specimen of PMMA-heatpolymerized silicone SDL with sandblasting-primer adhesive combination group.

Mixed failure was occurred in 40 % specimen of PMMA-heatpolymerized silicone SDL with sandblasting group and 60% specimen of PMMA-heatpolymerized silicone SDL with sandblasting-primer adhesive combination group.

Figure 4: Cohesive failure mode of PMMA-heatpolymerized silicone SDL after molloplast primer adhesive

Effect of surface treatment to bond strength of PMMA-autopolymerized siliconeSDL and PMMA-heatpolymerized silicone SDL correlated to difference morphology result of PMMA surface treatment which have been seen by SEM (Figure 5). SEM view of control group exhibited the regular scratch with horizontal line and parallel pattern (Fig.5a). SEM view ofsandblasting surface treatment exhibited the rough surface, sharp and irregular shape pattern with narrow and superficial angle pores (Fig. 5b). SEM view of mollosil primer adhesive exhibited the pumice stone with flat rough surface and several sizes of round pores which is spread evenly but not correlated to one another (Fig. 5c). SEM view of sandblasting-mollosil primer adhesive combination exhibited the pumice stone with protruding rough and sharp surface and small sizes of round pores which is spread evenly but not correlated to one another (Fig. 5d). SEM view of molloplast primer adhesive exhibited the trabecular pattern with thick bulging rough surface and several large sizes of round pores which is spread evenly and correlated to one another (Fig. 5 e). SEM view of sandblasting-molloplast primer adhesive exhibited the trabecular pattern with thin bulging rough surface and several angle pores which is spread evenly and correlated to one another (Fig. 5 f).

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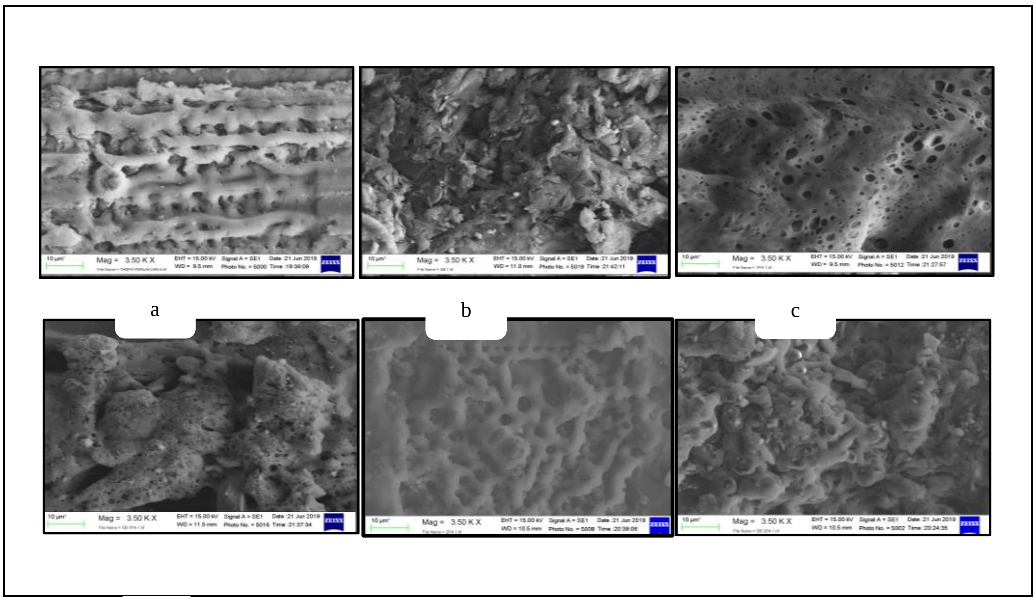

a b c

d e f

Figure 5: Poly (methyl methacrylate) surface roughness view after different surface treatment protocols with 3500 x magnification SEM (Carl Zeiss EVO MA10, Japan)

(a) Control Group (no surface treatment) (b) Sandblasting (c) Mollosil primer adhesive (d) Sandblasting + Mollosil Primer adhesive (e) Molloplast primer adhesive (f) Sandblasting + Molloplast primer adhesive

VI. DISCUSSION

This study compared the bond strength between PMMA-autopolymerized silicone SDL and PMMA-heatpolymerized silicone SDL. It showed that there was significance difference of bond strength between PMMA-autopolymerized silicone SDL and PMMA-heatpolymerized silicone SDL. PMMA-heatpolymerized silicone SDL was higher bond strength than PMMA-autopolymerized silicone SDL either without or with surface treatment. PMMA-autopolymerized silicone SDL group without surface treatment showed the bond strength value under 0,44 MPa but PMMA-heatpolymerized silicone SDL group without surface treatment showed the bond strength value above 0,44 MPa. All specimen of PMMA-autopolymerized silicone SDL after surface treatment still resulted adhesive failure mean that tensile strength of its silicone SDL was greater than its bond strength to PMMA surface. Partially specimen of PMMA-heatpolymerized silicone SDL after surface treatment resultedcohesive failure, mixed and adhesive failure. The highest bond strength was PMMA-heatpolymerized silicone SDL with primer adhesive exhibited with cohesive failure to all specimen. It mean that bond strength of heatpolymerized silicone SDL to PMMA surface was greater than tensile strength of silicon SDL. Bond strength of PMMA-heatpolymerized silicone SDL was better than bond strength of PMMA-autopolymerized silicone SDL probably due to the extra polymerization provided by the warm bath in water, at a temperature of around 60ºC (7). The continued cross-linking process resulted greater cross linking produced denser material which are devoid of micro pockets of water within the material (7, 8). Other caused by different chemical composition between them that can influence its bond strength to PMMA surface. The composition of an autopolymerized silicone SDLis dimethylsiloxane material consisted with base and catalyst. It same with silicone impression, high viscosity that crosslink with room temperature make a good elastic rubber. Therefore bond strength of molecule autopolymerized silicone SDL was greater than its bond strength to PMMA surface. High viscosity and crosslink in room temperature make it cannot penetrate easier to PMMA surface modification. While the composition of heatpolymerized silicone SDLis polydimethylsiloxane polymermaterial with organic peroxide (benzoyl peroxide) in pasta form. Both of two materials properties iscrosslinkwith free radical resulted by decomposition of organic peroxide material at high temperature. Therefore, the bond strength of heatpolymerized silicone SDLwas higher than autopolymerized silicone SDL either with or without surface treatment. This finding was similar with study of Mahajan N and Datta K (6).

Surface treatments produced a roughened modification of the PMMA surface. The roughened surface were approximately double those increase the bond strength than the smooth surface (14, 15). The roughened surface resulted the friction, so the failure was not easier occurred (4,23). This study resulted that all surface treatment can increase the bond strength PMMA-autopolymerized silicone SDL. Sandblasting can increase the bond strength of PMMA-autopolymerized silicone SDL but the increasing value of its bond strength still under 0,44MPa while primer adhesive and sandblasting-primer adhesive combination resulted bond strength value above 0,44 MPa. Primer adhesive gave significant effect to increase the bond strength of PMMA-autopolymerized silicone SDL. This study appropriate with Atsu S and KeskinY (10), Bayati OH, et al (33) and Cavalcanti, et al (26) and was not similar with Philip, et al (13). It can be correlated with different morphology view of PMMA surface after surface treatment. Primer adhesive (mollosil) exhibited rough surface with several large, deep and round-correlated pores while Sandblasting exhibited the rough surface, sharp and irregular shape pattern but narrow and superficial angle pores, and Sandblasting-primer adhesive combination exhibited the rough surface with smaller sizes of round pores. Small size, superficial depth and angle pores caused autopolymerized silicone SDL cannot penetrate easier to PMMA surface.Beside that, it self material properties and the residu particle of sandblasting that entrap and didn’t through away after cleaning the surface of PMMA can influence the bond strength of PMMA-autopolymerized silicone SDL.

Sandblasting, primer adhesive and sandblasting-primer adhesive combination can increase the bond strength of PMMA-heatpolymerized silicone SDL. The lowest bond strength of PMMA-heatpolymerized silicone SDL was in group control and the highest one was in group primer adhesive (molloplast B). Sandblasting can increase the bond strength of PMMA-heatpolymerized silicone SDL with high bond strength value. It was appropriate with study of Usumez, et al (28), Akin H, et al (9) and Nakhaei, et al (14). It can be concluded that larger size of alumina particle (250 μm) created larger and depth pores therefore the SDL could penetrate into them more easily (14). Primer adhesive gave significant effect to increase the bond strength of PMMA-heatpolymerized silicone SDL. This study appropriate with Korkmaz, et al (31). Factors assumed that primer adhesive (molloplast B) have silane treatment fillers with coupling agents. It can altering the mechanical properties of elastomers and also reduce water (7). Primer adhesive (mollopast B) exhibited rough surface with several large round pores while sandblasting exhibited rough surface with several angle pores and sandblasting-primer adhesive combination exhibited the rough surface with several angle pores. Primer adhesive SDL can washes away microdebris and producing a cleaner surface for bonding and the swelling and porosities of the denture base enhance the penetration of soft lining material or it's adhesive to these porosities, thus a type of interlocking was created (25). Beside that, the residu particle of sandblasting that entrap and didn’t through away after cleaning the surface of PMMA can influence the bond strength of PMMA-heatpolymerized silicone SDL.

The difference effect of 3 kinds of surface treatment to PMMA-heatpolymerized silicone SDL and to PMMA-autopolymerized silicone SDL were analyzed. Sandblasting or sandblasting-primer adhesive gave better effect to bond strength of PMMA-heatpolymerized silicone SDL than to PMMA-autopolymerized silicone SDL. It was caused by sandblasting residu that entrap to pores of PMMA surface can pass away at crosslink in high temperature. High temperatures during polymerization could facilitate the diffusion of SDL molecules into the denture base material, thereby creating better bonding to PMMA-heatpolymerized silicone SDL. Sandblasting-primer adhesive combination gave better effect bond strength to PMMA-heatpolymerized silicone SDL than sandblasting assumed that the empty holes can be filled by primer composition and its SDL material during polymerization at high temperature.

The difference effect of Primer adhesive, Primer adhesive (molloplast B) to PMMA-heatpolymerized silicone SDL gave the higher significance effect than primer adhesive (mollosil) to PMMA-autopolymerized silicone SDL. It caused by high temperatures during polymerization that could facilitate the diffusion of SDL molecules into the denture base material, thereby creating better bonding to PMMA-heatpolymerized silicone SDL(7). Morphology view of PMMA surface can analyzed to determine the difference. Large size, depth and round-correlated pores of PMMA surfaces after molloplast primer adhesive while smaller size, superficial and angle pores with or without correlated of PMMA surfaces after mollosil primer adhesive. It can be assumed that size, depth and shape of pores. The difference effect of sandblasting to PMMA-heatpolymerized silicone SDL and to PMMA-autopolymerized silicone SDL showed that sandblasting gave significance effect to PMMA-heatpolymerized silicone. This study similar withUsumez, et al (28), Akin H, et al (9), Nakhaei M, et al (14). Sandblasting may increased the bond strength of to PMMA-autopolymerized silicone SDL but its not accepted to clinical use because its bond strength value were still under 0,44 MPa and resulted adhesive failure. SEM view ofsandblasting surface treatment showed the rough surface, sharp and irregular shape pattern but narrow and superficial angle pores. Therefore, autopolymerized silicone SDL cannot penetrate easier to PMMA surface. The lower bond strength values of air particle abraded specimens can be due to the stresses that develop at the interface of the polymethyl methacrylate resilient liner junction as the surface irregularities created by air particle abrasion may not allow a complete flow of soft denture liner and may result in void formation by air entrapment and on the penetration coefficient of the lining material; because the penetration coefficient is inversely proportional to viscosity (31)

The most appropriate testing is like the mouth environment caused of water resorption and aging factor that can influence the long term effect of surface treatment. Nakhaei, et al (14) and Kulak Ozkan, et al (19) exhibited that 5000 thermocycling, assumed 5 years used, can decrease the bond strength of silicone SDL. In this study there is no thermocycling as the limitation. However, the effect of aging and the oral environment on the longevity of these treatments was not evaluated in the present study. Thus, the survival rate of the adhesion between the denture base and resilient relining material after these PMMA surface treatments protocols should be evaluated to achieve adequate clinical performance.

VII. CONCLUSION

The Primer adhesiveapplication on the PMMA surface gave the highest significance effect to PMMA-heatpolymerized silicone SDL characterized either with highest bond strength values, cohesive failures and highest roughened surfaces of PMMA interface. The clinical use of the evaluated primer is viable for resin-based soft liners.

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