Journal of Research in Medical and Dental Science
2018, Volume 6, Issue 1, Page No: 263-268
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Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

The Effect of Adding 1% Titanium Dioxide to Heat Cure Poly methyl methacrylate on the Shear Strength of Acrylic Teeth Bonding

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DOI: 10.24896/jrmds.20186143

ABSTRACT

Detachment of teeth from the denture base is one of the most common failures in patients with the dental prosthesis. Heat cure acrylics are widely used as denture materials. The purpose of this study was to investigate the effect of adding 1% nanotyitanium dioxide to heat cure poly methyl methacrylate on the bond strength of the teeth. This study was conducted experimentally and in vitro, in which 40 acrylic anterior maxilla teeth were divided into two groups. Group A (study group) consisted of 20 acrylic teeth mounted on blocks made of heat cure poly methyl methacrylate that 1% wt. of titanium dioxide was added. Group B (control group) consisted of 20 acrylic teeth mounted on blocks made of heat cure poly methyl methacrylate. Each of these teeth was mounted on a cylindrical pattern, the shear bond strength of the two components was measured using a universal testing machine, and the results were analyzed using t-test. In this experimental study, 40 samples were examined by means of tests. The mean shear bond strength of the study group was 82.2356 MPa more than the control group and the t-test was used to test the significance of this difference. Considering the significance level of more than 0.05, it can be concluded that there is no significant difference between the mean of the study and control group. The results indicate that adding 1% wt. of Tio2 to heat cure poly methyl methacrylate does not disrupt the bond strength of the tooth.

Keywords: Dentures, Strength, Shear, Titanium Dioxide, Poly Methyl Methacrylate

HOW TO CITE THIS ARTICLE: Loghman Ghahramani, Rahmat Saeidi, The Effect of Adding 1% Titanium Dioxide to Heat Cure Poly Methyl Methacrylate on the Shear Strength of Acrylic Teeth Bonding, J Res Med Dent Sci, 2018, 6 (1): 263-268, DOI: 10.24896/jrmds.20186143

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Received: 15/011/2017
Accepted: 12/12/2017

INTRODUCTION

The removal of artificial teeth from denture bases is a major problem in patients with prosthetics. Previous studies have shown that 26% -33% of repair dentures are dedicated to teeth detachment from denture bases. Which repair and repair is very difficult, costly and time consuming. [1-2] The separation of the two components of the prosthesis can be due to many factors and depends on a variety of factors, including the material [denture base-tooth] [3-4], processing factor [heat cure, self cure] [5-6], Availability of monomer during processing [7-8] and the entry direction of functional forces [9-10]. Many studies have been done to improve the acrylic teeth band to the denture base, including scratching techniques at the surface of the teeth to the base, moistening to the monomer or bonding surface of the teeth to the base, and creating grooves around the artificial teeth [11]. Poly methyl methacrylate (PMMA) is one of the materials that have been widely used in dental prostheses since 1937. This widespread use is due to certain features such as beauty, low absorption, lack of toxicity, repairability, and ease of use (one of the easy techniques of using this material is pressure-producing technique) [12-13]. But this material has the same disadvantages as any other material, along with its advantages, including the weak physical properties of the material [14].

On the other hand, a variety of artificial teeth is currently offered in making dental prosthesis, but among them acrylic teeth are more favored due to their advantages, including the ability of the chemical bond to acrylic base and the same chemical properties similar to Acrylic base [15], having high cross-linking, fracture toughness, and good resistance to Stain deposition [16-18]. The purpose of this study was to determine the shear bonding strength of acrylic of two acrylic base-acrylic teeth components after creating chemical changes in the composition of the heat cure poly methyl methacrylate. In this study, it has been tried to evaluate the bonding strength in the control group, and after adding TiO_2, and compare the two groups together.

In the following, some of the studies are mentioned in this regard. Sodagar *et al*., [19] conducted a study by adding (Titanium dioxide) TiO_2 and (Silicon dioxide) Sio_2 nanoparticles to acrylic with antimicrobial properties. They have conducted the study to investigate the effect of adding (Titanium dioxide) TiO_2 and (Silicon dioxide) Sio_2 on bending strength of poly methyl methacrylate. The results indicate that the addition of (Titanium dioxide) TiO_2 and (Silicon dioxide) Sio_2 will affect the acrylic bending strength. This effect has a direct correlation with the concentration of (Titanium dioxide) TiO_2 and (Silicon dioxide) Sio_2 [19]. Ghahramani *et al*., s conducted a study aimed at comparing the band of Iranian and foreign Ivoclar composite and acrylic teeth with heat cure and self cure polymerizing acrylics. In this study, they used two types of base resins (cold and heat cure) and four types of dentures (new coral acrylic, glamour composite (both Iranian) and composite and ivoclar acrylic), which were studied in 8 groups. In the end, it was concluded that the tooth type as well as the base-acrylic polymerization method affected the bond strength [20].

MATERIALS AND METHODS

The statistical population of the study was acrylic samples made in dental patients. This study was conducted experimentally and in vitro. The cylinders with a diameter of 25mm and 30mm height were made with Toughened dental modeling wax from Poly Wax Corporation. Then, an acrylic toothbrush SR ViVadent PE was fitted on each of these wax cylinders with 13 color A2 mount from Ivoclar Vivadent Company. In order to ensure that the depth of penetration of the acrylic tooth in the wax and the result of the contact surface of the tooth and acrylic base are the same in all models, initially a specified teeth to the hypothetical CEJ was placed in the wax by the factory and a Speed ex Putty index and a Speed-Ex Universal Activator of Coltene Company were taken and all other teeth were mounted considering this index. The samples were flasked according to dough technique and three blocks were inserted in each flask considering the dimensions of the wax blocks. The two-step gypsum technique was performed, so that the first gypsum covers up to half the wax block and half the width of the distal posterior tooth (Figure 1). Then, the surface of the gypsum as dipped with Acropars BF biofilm from Marlic Company to create an appropriate space and separate the two-step gypsum. Finally, the second stage was poured and pressed the flask under the pressure of 100 Pascal. After the gypsum setting and according to the usual technique, the wax was removed and the generators were prepared for acrylization.

Preparation of study group samples

In order to mix, at first, the commonly used powder of making SR Triplex Hot acrylic denture base from Ivoclar vivadent Company was mixed with 1% wt. Titanium Dioxide (TiO_2) anatase phase with a particle size of 20 to 30μm. Thus, the heat cure acryl powder was mixed with 1% by weight ratio of titanium dioxide powder uniformly with the vibrating device. After preparing the mixing powder, the methyl methacrylate powder was mixed with monomer according to the instructions of the factory. The resulting paste was used to acrylate the required samples. Therefore, the heat cure poly methyl methacrylate with 1% by weight ratio of titanium dioxide was replaced in 20 of the samples after the removal of the wax. In 20 other models, only the heat cure poly methyl methacrylate was inserted. After acrylizing, the generators were pressed at a pressure of 2000 Pascal. Then the models were heated according to the factory's [temperature-time] schedule.

Figure 1: Flasking

40 samples were made, in which 20 samples were used by the heat cure poly methyl methacrylate with 1% by weight ratio of titanium dioxide and the other 20 samples were made by heat cure poly methyl methacrylate. Teeth used in each group include:

8 central teeth, 4 lateral teeth, and 8 canine teeth. After heating, they were polished using polishing tires. Thus, the samples were prepared for a shear strength test using a Universal testing machine. First, the sample was closed on the device and then, the device applied the shear force to the teeth at a speed of 5mm/min. Finally, the maximum tolerable force by the sample (the force in which the tooth is completely removed from the acrylic block) was recorded in MPa. The data were then analyzed using T-test.

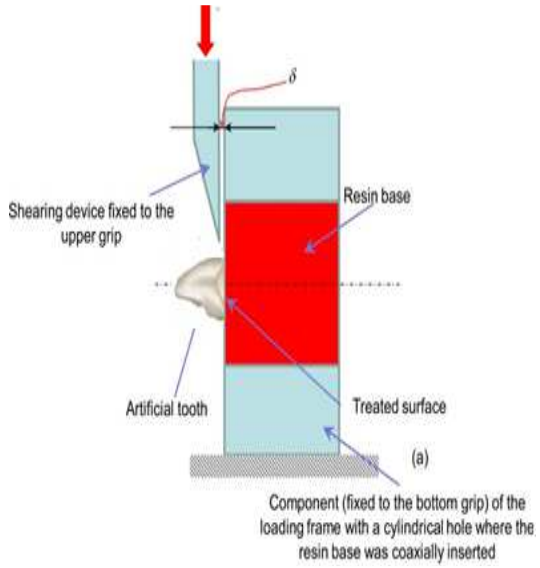

Figure 2: Schematic of the model on the Universal testing machine

RESULTS

Comparison of shear bond strength of two groups

The mean shear bond strength of the two acrylics was as follows. In the study group, in which 1% titanium dioxide was added, the mean of data was 575.574MPa and this value was 491.3384MPa in the control group with normal acrylic (Table 2-4), which is shown in Figure 3.

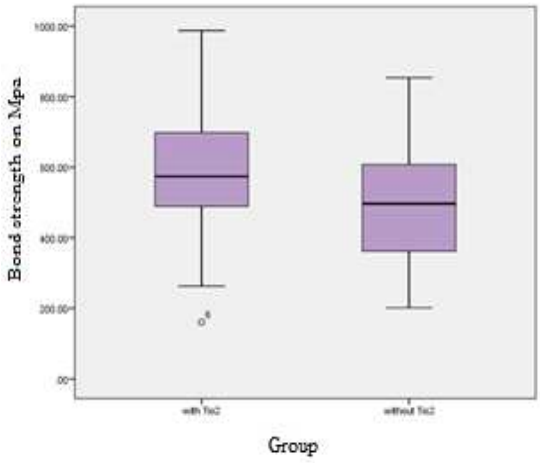

Figure 3: Boxplot of shear bond strength of the study group and control group

Table 1: Shapiro-Wilk test

Group	Statistics	Degrees of freedom	Significant level
Study Group	0.945	20	0.304
Control group	0.978	20	0.928

Given the significance level of all variables, which are greater than 0.05, the null hypothesis based on the non-normality of the data was rejected. It can be concluded that all variables have a normal distribution and according to the normality of the data and the number of samples, the T-test was used to compare the means.

The difference between the shear bond strengths in the study and control groups

T-test was used to compare tensile strength difference between study and control groups. The descriptive statistics are shown in Table (2).

Table 2: Descriptive statistics of the study and control groups

	No.	Mean	Variance	Median	Min.	Max.
Group A	20	574.03	31549.55	573.57	160.77	987.36
Group B	20	496.35	27243.37	491.33	201.52	853.52

As can be seen, the mean shear bond strength of the study group is 82.2356 MPa unit more than the shear strength of the control group. To test the significance of this difference, a t-test was used which shows the results in Table (3).

Table 3: T-Test result

Shear strength	T	Degrees of freedom	Significant level
Control group-Study group	1.517	38	0.07

According to the above table, the mean comparison between the two groups was not statistically significant (Pv = 0.07).

Shear bond strength of the study group.

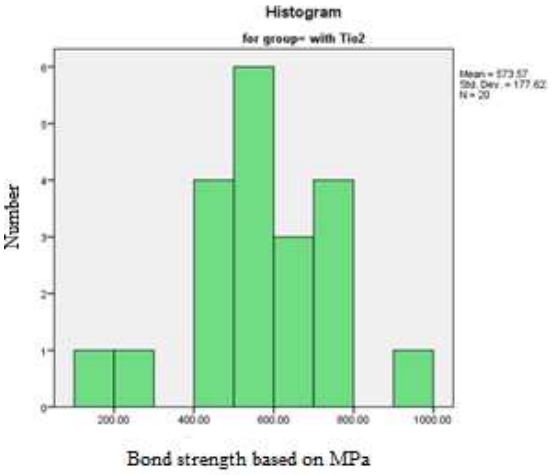

Figure 4: Shear bond strength histogram of the study group

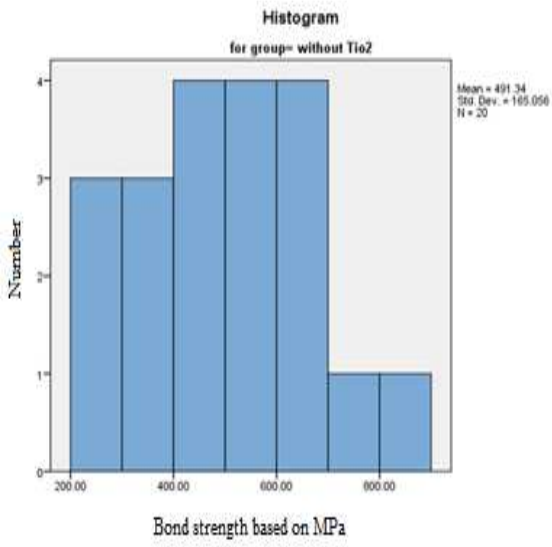

Figure 5: Shear bond strength histogram of the control group

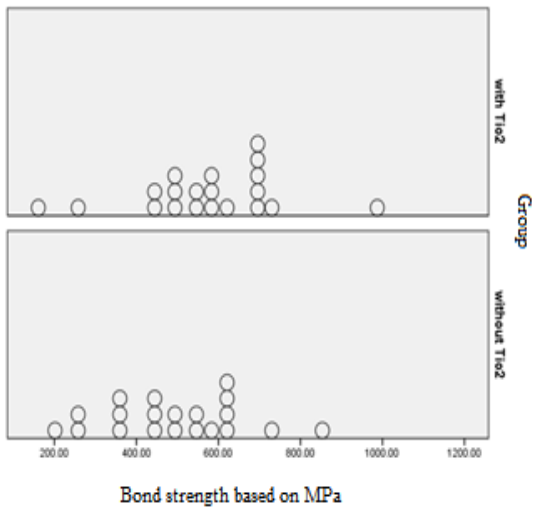

Figure 6: Scatter plot of the shear bond strength of the study group and control group

DISCUSSION

One of the common problems in patients with parsil and complete denture is the detachment of acrylic teeth from denture base that difficult to repair. They are often repaired with acrylics whose shear bond strength is less than before, and more teeth may fall out again. As a result, finding a way to improve the shear bond strength should be considered. In this study, 1% nanotyitanium dioxide particles were added to acrylic base. The

results showed that although the mean shear strength of the study group was higher than the control group but due to the lack of significant data, it can be said that the addition of titanium dioxide particles to poly methyl methacrylate does not alter the strength of the acrylic shear bond to the teeth. In the study group, in which 1% titanium dioxide was added, the mean of data was 575.574MPa and this value was 491.3384MPa in the control group with normal acrylic (P-value=0.07). As many studies have been carried out to improve the physical properties of heat cure acryl including the study by Sodagar et al. [19], they added heat cure Tio_2-SiO_2 to the acryl and found that the strength of the acrylic bend will increase by adding these particles.

Ebadian *et al*., [21] conducted a study entitled "Investigation of the effect of aluminum oxide powder on some of the physical properties of heat cure acryl". They found that the addition of spherical aluminum oxide particles to acrylic increases the bending and the elasticity of acryl. In this study, 1% concentration was used to investigate the effect of adding titanium dioxide on the bond strength. In the study of Shirkvand and Moslehi Fard, the best weight percent of titanium dioxide was 1% by weight. Adding this amount of nanotyitanium dioxide powder increases and improves the mechanical properties of acrylics, including tensile strength with mean (79.16 ± 5.68 MPa) in the group with adding 1% titanium dioxide. In contrast, the mean (61.77 ± 6.81 and 65.88 ± 5.31 MPa) were in groups with 2% and 5% internal titanium dioxide and (59.22 ± 4.02 MPa) in the control group.

In addition, in the present study, increasing acrylic contact and acrylic teeth improves the bond between the teeth and acrylics so that the mean of canine and central arylic teeth group were (574.48 and 613.32 Mpa) with a greater cross-sectional area than the lateral acrylic teeth with mean (489.24 MPa). Margaret *et al*., [22] conducted a study on 180 samples. The bond strength of the three types of heat cure and self cure acryl were compared under pressure. On the other hand, the contact surface of the acrylic toothbrush was impregnated with five types of substances such as Ethylacetate -Monomer-chloroform-Acetone-Cyanoacrylate. In this way, they compared 18 groups and concluded that the highest bond is between the acrylic teeth with under pressure heat cure acryl. In addition, smearing the tooth surface with above materials except for Cyanoacrylate increases the band, among which Ethylacetate has the greatest impact. On the other hand, Mahadevan [23] damaged the contact surface of acrylic tooth by three chemical methods (heat cure monomer methyl methacrylate) and sandblast and retentive groove). They found that the highest strength was in the group that was created at the contact surface of the retentive groove tooth.

In this study, acrylic ivoclar teeth (SR ViVadent PE of 13 color A2 from ivoclar vivadent) were used to evaluate the bond between the acrylic base with the acrylic teeth. Ghahramani *et al*., [20] compared the band of acrylic and composite teeth of the Iranian ideal Makoo and foreign ivoclar to heat cure and self polymerizing acryl. They concluded that the type of tooth, as well as the base-acrylic polymerization method, has an effect on bond strength. By adding these particles to acrylics during the test, we found that the addition of nano-titanium dioxide particles to the acrylic powder should add more monomer to the acrylic dough than usual. In addition, adding titanium dioxide to acrylic will result in lessening of the dough and base, which is also reported in Acosta and Torres [10]. It is necessary to use pigment and staining in the case of adding titanium dioxide to improve the appearance properties.

CONCLUSION

It is concluded from this study that the addition of 1% wt. of titanium in oxide to the heat cure poly methyl methacrylate does not undermine the shear bond strength of the two acrylic components. Increasing the contact surface of the teeth and acrylic also increases the shear bond strength. When acryl is being prepared for the generation, more monomer should be added when adding titanium dioxide to poly methyl methacrylate. Due to the addition of titanium dioxide, the color of the acrylic becomes fade. It is suggested to use more than 20 samples per group and one tooth with the same cross section in future studies for more standardization of the data.

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