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Shear Bond Strength of Acrylic Denture Teeth to Different Pmma/Mgo % Reinforcing Nanofillers

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Abstract

Aim of the study: The objective of this study was to evaluate the shear bond strength of acrylic denture teeth to different PMMA/MgO % (2%, 4%, and 6%) reinforcing nanofillers

Materials and method: 40 specimens of heat cure acrylic resin (PMMA) were prepared and divided into four groups 10 specimens for each group as follows; Control Group (Group1) without MgO nano filler particles; Group (2) with 2% by weight of MgO; Group (3) with 4% by weight of MgO and Group (4) with 6% by weight of MgO. Wax pattern sample which used for acrylic cylindrical shape fabrication were (25 mm in length and 5mm in diameter, the base of the cylinder which is 5mm in thickness and 8mm in length). Shear bond strength of all specimens was evaluated.

Results: Showed in the PMMA+MgO 4% showed the maximum mean value of upper bound of shear bond strength which was equaled to (14.859) while the control group PMMA recorded the minimum value of lower bound of shear bond strength (8.190).

Conclusion: There was no significant difference between control group PMMA and (PMMA+MgO 2%, PMMA+MgO 6%), but there was a significant difference between PMMA+Mgo4% compared with control group PMMA.

Keywords: MgO nanofiller particles, heat cure acrylic resin (PMMA), shear bond strength (B.S).

Introduction

Acrylic resin (PMMA) denture base materials had good esthetics and restoration of function **(1)**. Tissue compatibility, color stability, dimensional stability, easy and accurate to fabricate and repair, takes up and retains high polish and should not be porous, absence of taste, insoluble and low sorption of oral fluids and able to duplicate the oral tissues **(2, 3, 4)**. It also has good impact strength, strong and light weight material **(5).** For all those excellent properties and the widespread use of (PMMA) in prosthetic dentistry the fracture between acrylic teeth and acrylic denture base resin is a common clinical occurrence in prosthodontics (**6 , 7)** . Recent studies suggested that nano oxide they can enhance the organic polymer's physical and optical properties, as well as provide resistance to cracking and aging caused by environmental stress **(8).** MgO nanoparticles consist of magnesium 60.29 and Oxygen 39.67, the MgO biomedical applications due to their unique properties high purity and a high melting point **(9).** Much attention has been focused on magnesium oxide nanoparticles because of their antibacterial activity against various pathogens **(10).** The shear bond strength of a material is known as its capability to resist forces it causes the material's interior construct to slide against itself, the shear strength dependent on cross-sectional area of a material **(11).** The current study aims to evaluate the shear bond strength of acrylic denture teeth to different PMMA/MgO % (2%, 4%, and 6%) reinforcing nanofillers.

Materials and method

Cylindrical shape (25 mm in length and 5mm in diameter) consists of two ends. One end set on it the tooth and the other end form the base of the cylinder which is 5mm in thickness and 8mm in diameter). The specimens were prepared according to ***(*Abu-Anseh, 2003 and Al-Huwaizi, 2005) (12, 13).*** as showed in Fig. (1)**.**

40 acrylic upper central incisors were used. They were had the same shape, size, and length of the teeth were measured by used an electronic digital caliper as shown in Fig. (2). Then were cut the cervical third of all the 40 teeth by used a laboratory engine **(14).** Then the teeth are fixed on the wax pattern of the specimens at 45° degrees by used geometric Protractor **(15).**

By weight the addition of nanofiller powder done in Four groups, involves 2%, 4%, and 6% to monomer, with sensitive balance high accuracy (±0.0000g, Mettle Type AE260-S SNR H50193) as in Fig. (3). The filler well dispersed in the monomer by Ultrasonic Homogenizer model 300 V/T (BIOLOGICS, INC.) type of mixing using (120W, 60KHz) for three minute to had homogeneous mixing as seen in Fig. (4). The suspension of the monomer with nanofiller was mixed instantly with acrylic powder to reduce the possibility of particle aggregation and phase separation **(16).** The rate of mixing for acrylic resin was (2.5g: 1ml) P/L according to the instruction.

The specimens were grouped as following:

1.First group (group1): control group 10 samples (without any addition).

2.Second group(group2): addition 2% MgO nanoparticles 10 samples.

3.Third group (group3): addition 4% MgO nanoparticles 10 samples.

4- Fourth group(group4): addition 6% MgO nanoparticles 10 samples.

Packing and Curing were done when the acrylic arrived at dough stage, the acrylic resin packing was started. The resin taken away from the Jar and rolled, then insert into the mould. The flask was at last closed under pressure (hydraulic press) till metal-to-metal contact and left under press 20 bar for 5 min and transport to the water bath by placing the clamped flask in a water bath and cured by heating at 74°C for about one hour and a half and the temperature was raised to boiling drawer for 30 minutes [**17**]**.** Then deflasking & removing the acrylic specimens from the mould.

Every residual acrylic has been removed by a laboratory engine with an acrylic bur. To achieve a flawless finish a stone bur followed by a sandpaper in grain (120) with a constant refreshing effect. Polishing was masterful by using of bristle brush(vertex) with pumice then used POLI-R polishing gel with the rouge wheel in lathe polishing machine, a luster surface was done. Then placed in a glass jar with an aluminum cap 25ML containing distilled water and placed in the incubator at 37°C for (48 hours) before testing **(16)**.

The Specimens were loaded until brake and a load of brake was recorded by (mode lwdw50 manufactured by Laryee) as seen in fig. (5). The shear bond strength, using a stainless-steel chisel-shaped rod, this was used to deliver the shearing force with a crosshead speed of 0.5 mm/min (ISO TR 11405). The load cell was set at 100 Kg, was based on the force (F) in (N) at fracture and adhesive surface area (S) in (mm2) and converted to (Mpa). according to (**15,18)** in the following figure (2), the formula below

$$B.S = F / S$$

B.S = Bond strength (N/mm2) or (MPa),

F= Force at failure (N)

$S = (\pi / 4) \times D2$; $\pi = 22/7$ or 3.14, D (diameter) = 5mm, S = 19.64 mm2.

After testing shear the PMMA with addition difference percentage of MgO nano practices, the site of the fractures was examined under SEM (Inspect S50) in the university of technology department of applied sciences as in Fig. (6)**.** The Surfaces and morphology after addition nanoparticles to PMMA in different concentration were examined by ANOVA (LSD).

Results

The study descriptive statistics dependent variable of groups: Number, mean, and S.D value of shear bond strength of groups as showed in Table (1). The maximum mean value was recorded by group3 (13.5864) while the minimum mean value was recorded by group1 (9.4621), were shown in Table (1)

The results were obtained for the descriptive of multiple comparisons of groups (Mean Different (I-J), Std. Error, P-Value, Sig., Lower Bound and Upper Bound) of shear bond strength of groups were seen in Table (2). There was no significant difference between group1 and (group2, group4), but there was a significant difference between group3 compared with group1.Bar chart of the shear bond strength test for all groups was showed in Fig. (7)**.**

The descriptive of dependent Variable (shear Bond Strength of groups) involved (Mean, Std. Error, Lower Bound & Upper Bound) of (group1, group2, group3 and group4) were seen in Table (3), the mean value of shear bond strength test were varied according to the concentration of a nanofiller powder. In the group3 showed the maximum mean value of upper bound of shear bond strength which was equaled to (14.859) while in the group1 recorded the minimum value of lower bound of shear bond strength (8.190).

Results clearly showed the fracture site of PMMA under (SEM), after adding the different concentration of MgO nanoparticles to the PMMA to assess shear bond strengths between the acrylic teeth and denture base. Surface morphology of specimen and the distribution of nanoparticles can show by scanning electron microscopic in Fig. (8,9and10).

Discussion

From the results of shear bond strength test Fig. (7) the addition of MgO Nano-filler to heat cure acrylic affected increased a value of shear bond strength compared to the group1. Group3 had the highest shear bond strength and group1 had the lowest shear bond strength. The purpose of increasing the shear bond strength due to interfacial shear bond strength between nanofiller and matrix was high due to formation of cross-links or supramolecular bonding which coating the nanofiller and prohibit cracks by good bonding between nanofiller and matrix that led to increase of shear bond strength with the acrylic teeth [**15,19**]**.** The addition of MgO 4% nanofiller to PMMA forms an efficient network (3 Dimensional networks) of PMMA and MgO nanoparticles. PMMA chain transferred into 3D-network like chains at group3 of nanoparticles, therefore, led to uniform surface and moderate as shown in Fig. (10) and reduce in the segmental motion so the shear bond strength increased [**20**]**.** Group2 showed a reduction in shear bond strength when

compared with group3 and group4. This may be due to the high surface area of the aggregated nanoparticles which may reach nanofillers MgO within the matrix causing stress concentration around the aggregation of the nanoparticles and uneven surface which led to crack propagation [**19**]. as seen in Fig. (9). This study agrees with **(Singh et al, 2007)** [**21**].

Conclusions

1-The better result was recorded of the shear bond strength test recorded by group3 in comparison to the group1. The maximum mean value was recorded by group3 (13.5864) while the minimum mean value was recorded by group1 (9.4621)

2- Croup3 was recorded highest mean value of upper bound of shear bond strength which was equaled to (14.859) while the group 1 recorded the lowest value of lower bound of shear bond strength (8.190)

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3-There was no significant difference between group1 and (group2, group4), but there was a significant difference between group3 compared with group1.

Conflicts of Interest

The authors reported that they have no conflicts of interest.

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Table (1): The descriptive Statistic for shear bond strength.

Descriptive Statistics			
Dependent Variable: Shear Bond Strength			
Groups	**N**	**Mean**	**Std. Deviation**
PMMA	10	9.4621	2.69817
PMMA+MgO 2%	10	9.6484	2.58359
PMMA+MgO 4%	10	13.5864	1.22310
PMMA+MgO 6%	10	10.8327	1.70577
Total	40	10.8824	2.05265

Table (2): Multiple Comparisons shear PMMA to PMMA+MgO.

Multiple Comparisons							
Dependent Variable: Shear Bond Strength LSD							
(I) Groups	**(J) Groups**	**Mean Difference (I-J)**	**Std. Error**	**P-Value**	**Sig.**	**95% Confidence Interval**	
						Lower Bound	**Upper Bound**
PMMA control group	PMMA+ MgO 2%	-.1863	.90029	.837	NS	-1.9854	1.6128
	PMMA+ MgO 4%	-4.1243*	.90029	.000	S	-5.9234	-2.3252
	PMMA+ MgO 6%	-1.3706	.90029	.133	NS	-3.1697	.4285
*. The mean difference is significant at the .05 level.							

Table (3) Dependent Variable (shear Bond Strength of groups)

Groups				
Dependent Variable: Shear Bond Strength				
Groups	**Mean**	**Std. Error**	**95% Confidence Interval**	
			Lower Bound	**Upper Bound**
PMMA	9.462	.637	8.190	10.734
PMMA+MgO 2 %	9.648	.637	8.376	10.921
PMMA+MgO 4%	13.586	.637	12.314	14.859
PMMA+MgO 6%	10.833	.637	9.561	12.105

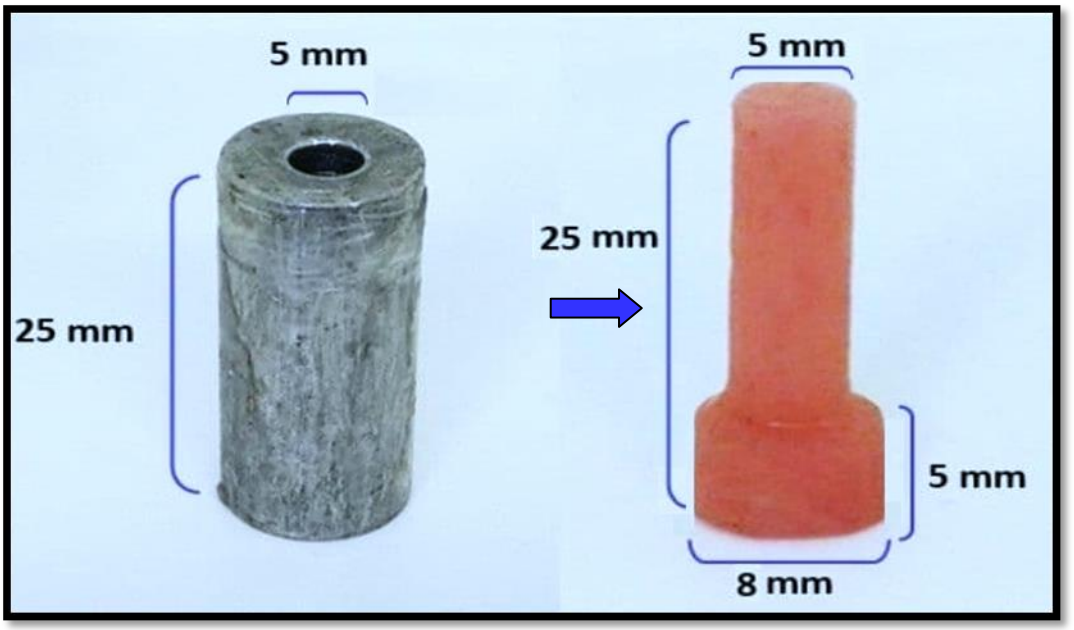

Figure (1): The specimens shape for the wax pattern.

Figure (2**):** Electronic digital caliper

Figure (3): Sensitive balance high accuracy (±0.0000g).

Figure (4): Ultrasonic Homogenizer model 300 V/T (BIOLOGICS, INC.).

Figure (5): shear bond strength.

Figure (6): The SEM devices.

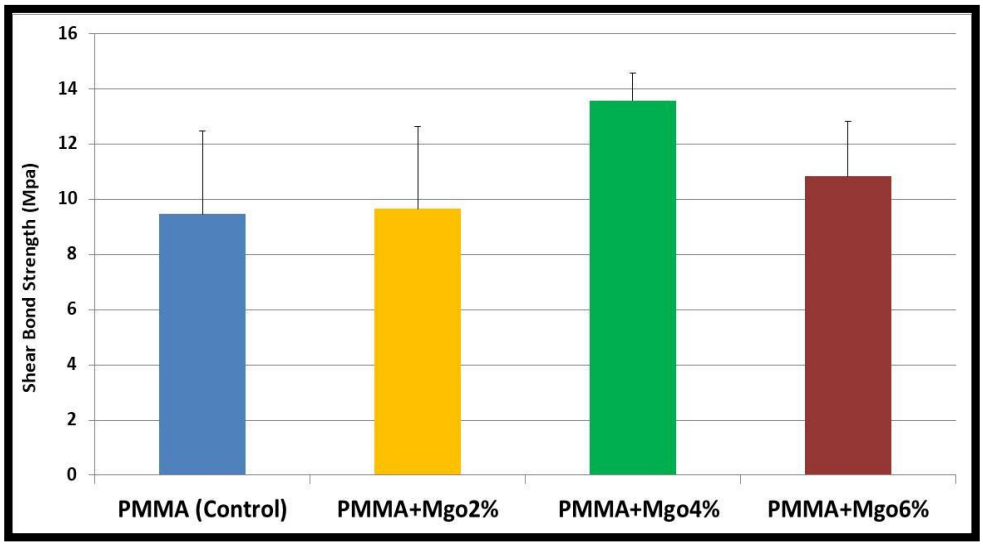

Figure (7): The bar chart for shear bond strength (Mpa) for PMMA+MgO.

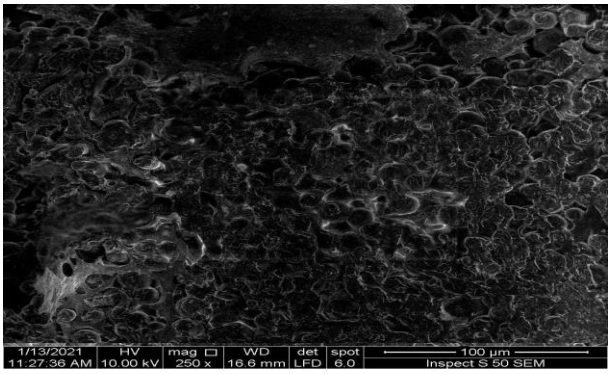

Figure (8): SEM for PMMA control group (shear bond strength).

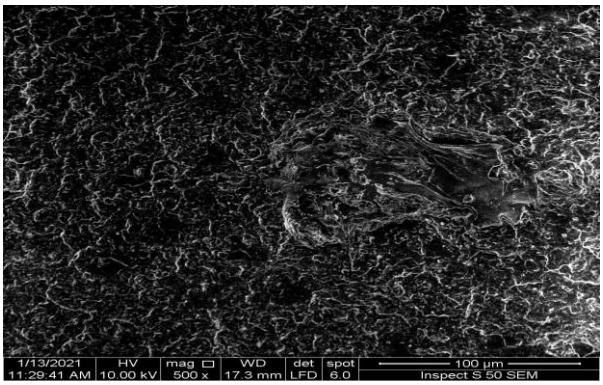

Figure (9): SEM for PMMA+MgO 2% (shear bond strength).

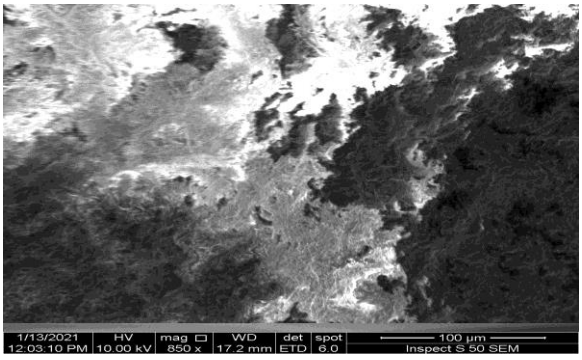

Figure (10): SEM for PMMA+MgO 4% (shear bond strength).