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Assessment The Mechanical and Color Changes Properties of Denture Base Material After Reinforcement with Nanoparticles Material

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Abstract

Although PMMA is widely used in prosthetic dentistry, but broken dentures are commonly known clinical events that remain as unsolved problems. The aim of this study was to evaluate the effect of incorporation Magnesium oxides nanoparticles with different concentrations on hardness and color changes of heat cure acrylic resin. A total of 40-disc shape specimens with a diameter of (12 ± 0.1) mm and a thickness of (2 ± 0.1) mm were prepared from heat cure acrylic resin. They were grouped into 4 groups according to nanoparticles concentrations (10) specimens for each group, then they are subjected to hardness and color changes tests.

Control group (A): (10 specimens) without addition. Group (B): 10 specimens of acrylic resin with (2%) concentration of MgO. Group (C): 10 specimens of acrylic resin with (4%) concentration of MgO. Group (D): 10 specimens of acrylic resin with (6%) concentration of MgO. The results showed there is high significant difference for MgO (2%, 4%) when compared with the controls. While there is no significant variation for MgO (6%). color changes showed there is a non-significant difference for all groups except for (6%) group which revealed there is high significant difference. Adding limited concentration of MgO (2%, 4%) have a positive effect on hardness of surfaces and color changes of heat-cured acrylic resins. any Increase in Concentration of MgO will effect adversely on hardness of surfaces and color stabilities of acrylic resin.

Introduction:

Polymethyl methacrylate (PMMA) is the most widely used denture base material. Since its introduced in dentistry as a denture base material due to their aesthetics, low cost, easy fabrication,

finishing and polishing, stability in the oral conditions, good fit, and easy repair. However, the base materials for acrylic resin dentures have poor strength, including low fatigue resistance and low

impact strength (1). Thus, denture fractures are frequent clinical events in prosthodontics services which remain as unsolved problems. Many attempts have been used to overcome these limitations and improvement of their physical and mechanical properties such as: incorporation of some rubber phase, changes in their chemistry, addition of multifunctional crosslinking factor such as polyethylene glycoldimethacrylate, metal oxides, metal wires or fiber oxides of (Al, Mg, Zr) (2). The inclusion of magnesium oxide in different dental materials was investigated and shown to be an important inorganic material, non-toxic and antibacterial agent (2,3). The hardness is the resistance of the material to an indentation or the amount of the resistance to wear or scratching (4,5). Another property that can influence the surface characteristics of acrylic resins is the color changes, which is the most important clinical characteristics of dental materials. It can indicate aging or material damage (2). In this study we investigate the effects of magnesium oxide with different concentrations on the surface hardness and color changes of heat-cured acrylic resins.

Materials and Methods:

Forty (40) heat-cured samples of acrylic resins have been prepared by conventional methods. Then, they are sub grouped according to concentrations of magnesium oxide particles that have been added. Firstly, silicon mold with a diameter of (12±0.1) mm and a thickness of 2(±0.1) mm was used for waxing specimens which have been flaked Fig. (1), (2). Then, metal flasks technique is used by coating them with separating medium (cold mold seal). The lower half is filled with dental stone then the disc shape wax is fixed on it, after the stone sets, separation medium was applied and left to dry. Following that, the upper half of flask was filled with stone and vibrated to prevent air entrapped. Then, wax elimination is accomplished according to instructions, the two halves of flasks are opened and coated with the separation

medium to be packed later. The mixing proportion of acrylic resins was 3/1 by volume (P/L), while the manipulation and mixing were based on the guidelines of the manufacturer. The mixing was performed in a dry clean jar, then it covered and left to stand until a dough stage was reached. Three different concentrations of magnesium oxide were selected in this study (2% ,4% and 6%). For each group, the electronic balance was used to weigh the required amount of the polymer and Mgo powders as shown in table (1). the premeasured amount of nanoparticles was added to the monomer and they are well dispersed by the use of probe sonication apparatus (120 W,100 KHz) for about 3 min. as shown in Fig. (3), after that the monomer and nanoparticle powder were mixed directly with the acrylic's powder in order to lower the particle aggregation possibilities and phase separations. Then, the mixture is left until the dough stage was reached. The packing stage was done after resin's reaching to dough phase. The acrylic was removed from glass container and packed in a flask which was coated with a separation medium and left to dry. Then, nylon sheets were used to aid in separation the two halves of the flask and remove or added another amount of resin. The flask's two halves are closed tightly and put at a hydraulic press. (85-90 bars for 1minute). The pressure was applied at a slow rate on flask and the flow of the dough was evenly done via the space of the flask. Then, the pressure is released and opened, then the excessive material is removed via using a sharp knife. Then, the closure for another time was done and a nylon sheet is removed. Finally, the flask's two halves were closed tightly and clamped to transfer to the water bath for curing in accordance with the guidelines of the manufacturer. Finally, disc samples are removed from the flask and hand finished by using acrylic bur to remove the excess flash of acrylic resin. The samples were stored in distilled water at 37C° for 48 hours before they were tested according to ADA specification NO.12,1999) (6). All the samples subjected to hardness test by using the hardness device, type (shore_D) scales according to (ASTM

D2240). The testing loads applied equally to 50 N, and the specimens located under the indenter area with a depressing time of measuring equal to 10 sec. The indicator of the digital shore-D device is 0.8mm in diameter, which tapers to the cylinder of 1.6mm. The indicator is pressed firmly, and readings were obtained from digital scales. Each scale results in a value between (0 to100) hardness numbers, with higher a value indicating a harder material as shown in Fig. (4). Finally, spectrophotometer UV (model UV 2601) was used to assessment the color stability in which the quantity of light absorption of the samples was measured by using a spectrophotometer as a measure for wavelength (2).as shown in Fig. (5).

Result and Discussion:

PMMA is a material of choice for denture base construction because of its favorable working properties, easy processing, accurate fits, stable oral environments, low cost with superior esthetic. Nevertheless, it isn't ideal due to its relatively reduced mechanical power that may lead to denture's fracture, thus, there are many reinforcement substances like metal oxides, clay mineral as well as fibers of Carbon graphite's (3). These particles' shapes, sizes and distributions play essential roles in the mechanical characteristics of the polymer's matrix (7). In the current study, the surface hardness and color changes of PMMA resin are evaluated after the addition of 2%, 4% and 6% of Magnesium oxide nanoparticles.

4.1. Hardness test of PMMA + 2%, and 4% MgO nanoparticles. From the results of the hardness test as Shown in Tables: (2), (3) and (4). The addition of MgO Nanoparticles to acrylic resin increased the value of surface hardness in Comparison with Control group, PMM + MgO 4% group had the highest Mean Value Than Control group. This can have explained by the interaction between the reinforcement material and the polymer matrix by Cross-link formation or supra-molecular bonding that coats nanoparticles and avoids the crack's propagation (8), (3) Their studies showed the highest mean

values for the reinforced groups with nanoparticles materials in Comparison with control group. However, PMMA +2% wt. of MgO showed increase in the mean value of when Compare with Control group, but it is the lowest mean value in Comparison with other groups. This may be due to the high Surface area of the aggregated nanoparticles which may reach within the matrix causing stress concentration around the aggregation of the nanoparticles and uneven surface which lead to crack propagation (9),(3). On the other hand, this low percentage may be acted as impurities within the PMMA which lead to decrease the hardness value or due to lack of chemical bond between nanoparticles and acrylic resin (1). The results of the current study agree with (1) who were evaluated the effect (2.5% and 5% wt. of Al₂O₃) nanoparticles on surface hardness of acrylic resin. Their Study showed there is non-significant difference in Surface hardness among reinforce groups. This may be due to undistributed particles of nanomaterial into the acrylic matrix or due to Low percentage of nanoparticles will be non-effected on surface hardness. The results of the current study agree with (3) who evaluated the effect of the 2% MgO on shear bond of acrylic resin with denture teeth their results showed Addition of this low percentage on acrylic resin reduced the mean Value of Shear bond in Comparison with other groups.

Hardness test of PMMA + 6% wt. MgO

According to the results of our study as demonstrated in table (2) in addition to one-way ANOVA test, there is non-significant effect of the groups reinforced with 6% wt. on hardness of acrylic resin. That explained by the too many of nanoparticles will effect adversely on the mechanical properties of acyclic resin, due to these particles will agglomerate, raising the action of impurity. That act as stress Concentration centers in the resin matrix and unfavorably will decrease their mechanical properties (10).

Color changes of PMMA

The alteration of color may indicate the material's damage or aging (11,12). In addition, appearance of aesthetic of a prosthesis is considered as an essential feature it demanded by a patient and that should meet his expectation (13). The color stability of (PMMA) is still far from ideal maintaining the longevity of dentures (14). According to the results of the current study as Shown in Tables (5), (6), and (7). They Revealed there is highly significant difference for the color changes of (PMMA with 6% Mgo) group in comparison with other groups (control, 2% and 4%).

That may be due to the different in wave lengths of the ultraviolet (UV) (spectrophotometer) light exposure reflected from the filler material and matrix in test groups. or maybe due to the attributed of residual monomers (15).

Conclusion:

In accordance with the results and limitations of the current in vitro study, we conclude the following:

- 1- Adding limited concentration of MgO (2%, 4%) have positive impacts on the hardness of surfaces and color changes of the heat-cured acrylic resins.
- 2- Any increased MgO concentration will affect adversely the hardness of surfaces and stability of colors of acrylic resins.

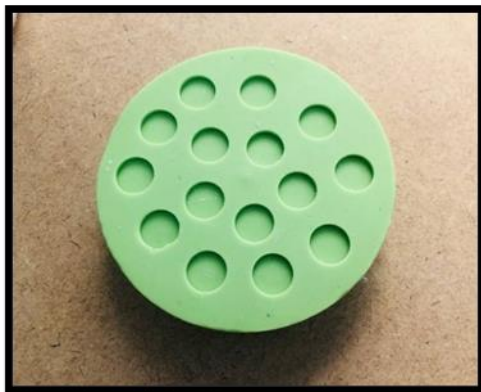


Figure (1): Silicon mould for waxing

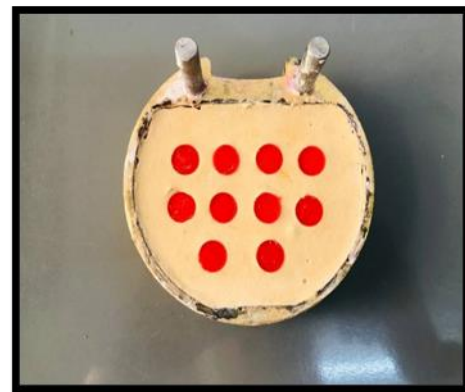


Figure (2): disc shaped wax specimens



Figure (3): probe sonication



Figure (4): D_ shore device



Figure (5): spectrophotometer (model UV- 2601) device

Table (1): Mixing ratio of acrylic resin with different nanoparticles concentration of MgO

Percentage	Amount of reinforcement (addition)	Amount of polymer	Amount of monomer
Control (0%)	0	100g	40ml
MgO (2%)	2g	98 g	40ml
MgO (4%)	4 g	96 g	40ml
MgO (6%)	6 g	94 g	40ml

Table (2): Descriptive statistics for hardness test group

Different%	GROUPS	Mean	SD	Min.	Max.
Control(PMMA)	Group A	65.0500	1.23491	63.00	66.50
PMMA with 2% MgO	Group B	68.1500	.85147	66.50	69.00
PMMA with 4% MgO	Group C	71.4500	.36893	71.00	72.00
PMMA with 6% MgO	Group D	70.1500	.24152	70.00	70.50

Table (3): One- Way ANOVA test for hardness test groups.

ANOVA	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	232.900	3	77.633	127.036	.000(HS)

Table (4): LSD test among groups of hardness test.

Groups		Mean Difference (I-J)	P-Value	Sig.
Group A	B	-3.10000*	.000	(HS)
	C	-6.40000*	.000	(HS)
	D	-5.10000*	.000	.(HS)
Group B	C	-3.30000*	.000	.(HS)
	D	-2.00000*	.000	.(HS)
Group C	D	1.30000*	.001	(NS)

Table (5): Descriptive Statistics of color changes among groups.

Name of groups	N	Mean	SD	SE	Minimum	Maximum
Control	10	3.73	0.112	0.035	3.59	3.89
Mgo 2%	10	3.69	0.115	0.036	3.54	3.89
Mgo 4%	10	3.72	0.121	0.038	3.54	3.88
Mgo 6%	10	2.42	0.107	0.034	2.23	2.54
Total	40	3.38	0.576	0.091	2.23	3.89

Table (6): One- Way ANOVA test for color changes groups.

Nanoparticle acrylic group	F	Sig.	Sig
Among group	318.517	.000	H.S

Table (7): LSD test of color changes among groups.

Group	Groups	Mean Difference	Std. Error	Sig.
Control	Mgo 2%	.04760	.05115	0.358
	Mgo 4%	.01890	.05115	0.714
	Mgo 6%	1.31270*	.05115	.000
Mgo 2%	Mgo 4%	-.02870	.05115	0.578
	Mgo 6%	1.26510*	.05115	.000
Mgo 4%	Control	-.01890	.05115	0.714
	Mgo 6%	1.29380*	.05115	.000
Mgo 6%	Mgo 4%	-1.29380*	.05115	.000

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