

EFFECT OF NANO SILVER AS ADDITIVE BY DIFFERENT WAYS TO ACRYLIC DENTURE BASE AND ITS ROLE IN MENOPAUSAL WOMAN MANAGEMENT

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ABSTRACT

Background and aim: Polymethyl methacrylate (PMMA) is broadly used as a removable prosthesis denture base. Silver Nano-particles (AgNPs) had been included to PMMA because of their antibacterial homes and higher thermal conductivity, at the same time as it had a destructive effect on the flexural strength and coloration stability that is probably resulted from the inhomogeneous combination. The motive of this research changed into to discover whether the addition of (AgNPs) to PMMA either in liquid form or in powder nation can enhance the flexural strength and the shade balance of PMMA. Also evaluating an edentulous menopausal lady as a multidisciplinary control after wearing a denture made from silver nanoparticles added to (PMMA) denture base.

Materials and methods: Fifty specimens of heat cure acrylic resin had been organized for flexural strength and color stability. Twenty-five for each test that become divided into 3 groups. Group 1 was the control group (unmodified acrylic resin specimens) and group 2 turned into Nano silver introduced within the form of powder to the polymer of (PMMA), while group 3 was Nano silver brought in the form of liquid to the monomer of (PMMA). Group 2 and 3 specimens had been break up into subgroups A and B 5 each, with 0.2%, and 0.4 % wt. of Nano silver addition to (PMMA) respectively. A flexural strength was measured via the usage of an Instron regular testing machine. A double beam ultra-violet visible spectrophotometer was checked to the degree of coloration stability. One edentulous menopausal woman that present process treatment below a gynecologist for menopausal signs and symptoms was selected as a case report and received denture made out of silver nanoparticles added to acrylic resin and patient satisfaction became evaluated after 4 months. The results have been gathered tabulated and statically analyzed.

Results: There has been a massive distinction in the flexural power values among all corporations ($p < 0.05$) relative to the non-changed heat treatment (control group). Acrylic resin samples with 0.2% in liquid additive form (3A) ended in more flexural power then 0.4% addition (3B) in comparison to different changed groups. The samples with 0.4 % in powder form (2B) had a lowest

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flexural strength in comparison to the all groups ($p < 0.05$). In comparing the color variations (ΔE) comparable to control group, group 3A and group 3B, showed lowest color variations respectively. At the same time group 2A and 2B ended in highest shade distinction .

Conclusion: Set up on the effects of this results, modifying PMMA with Nano silver debris led to lower in flexural strength and shade stability, addition of Nano silver particles in liquid shape was higher than powder form as concerning flexural strength and better color difference and the addition percentage of 0.2 became better than 0.4. Menopausal pride turned into higher and her complain became managed with the new denture.

KEY WORDS: Acrylic resin, Nano silver-particle, flexural strength -color stability- menopausal woman

INTRODUCTION

A denture base material has to possess biocompatibility with the oral tissues, superior mechanical residences, super esthetics and antibacterial effect¹. An acrylic resin are appreciated for complete denture fabrication due to the noticeably ease manipulation and production methods plus the low value material. Acrylic resin is colorless and transparent at an everyday temperature/ stress values. But, it isn't the suitable material in each property².

One of the top negative aspects of polymethyl methacrylate (PMMA) resin is its low thermal conductivity. Furthermore, flexural fatigue of dentures as manifested with the aid of midline fracture is due to the stress attention around the micro cracks formed in the material due to non-stop programs of small forces^{3,4}. Fracture of dentures in carrier has been worried, and several attempts had been made to improve flexural and impact power of PMMA. Researches in those areas aimed to adjust the composition or strengthen the PMMA with other stronger substances for growing new substances with higher houses.

Due to those drawbacks and with the purpose of enhancing the properties of acrylic resin, debris of materials can be introduced to the liquid or powder of acrylic resin and polymeriz⁵. As an instance, incorporating silver materials⁶, alumina and an oxide ceramic⁷⁻⁹ has been used. Silver is a metallic

with excessive conductivity, its antimicrobial properties have been mentioned in several studies whilst delivered to the denture base inside the form of nanoparticles^{10,11}.

Nanotechnology has shared inside the development in substances used in medicinal drug, as it may provide better functionality, due to the nano metric sizes involved .silver nanoparticles [AgNPs] that exhibit distinctive properties once they may be carried out to organic structures, in comparison with traditional structures of treatment. The Nano scale lets in the materials the capability to penetrate into distinct organic membranes, which include bacterial cellular walls, thereby increasing bactericidal effect¹². The Nano scale scope (1–one hundred nm) used to symbolize nanoparticles ought to not be considered strict, because of the variations which could exist in the nanoparticle shape, surface location-to-mass ratio and composition¹³.

Nowa days, a greater attention has directed towards the addition of nanoparticles into PMMA to enhance its properties. The residences of polymer Nano composites depend upon the sort of included nanoparticles, their length, and form as well as the awareness and interaction with the polymer matrix¹⁴. Consequently, a way of incorporating silver nanoparticles (AgNPs) into acrylic resin denture base substances to beautify its fatigue conduct, effect electricity, and thermal conductivity. But, there are some discrepancies among the effects of those studies¹⁵.

Improvement of acrylic resin with AgNPs appreciably depends on its concentration. Right concentrations to PMMA can improve its mechanical characteristics without any detrimental results. because adding AgNPs by 2 wt% decreased the tensile strength of acrylic resin, AgNPs with 0.2 and a couple of wt% extended the compressive power of acrylic resins, but increasing AgNPs awareness from 0.2 wt% to 2 wt% did not improve compressive energy of acrylic resin drastically. The acrylic resin is a brittle material however at compressive situations behaves like ductile materials¹⁶.

Esthetic troubles rise up from discoloration of acrylic resin. The addition of a silver compound to acrylic resin as a measure in opposition to odor and bacterial proliferation inside the oral cavity has been studied; however undesirable color adjustments have tended to arise¹⁷. Coloration balance is a vital belonging of a denture liner to retain its color in distinct surroundings, specifically in long-term use. Color evaluation and its reproduction is one of the most difficult components of dentistry. Visual shade matching is still the primary method for comparing the color and can cause dissatisfying results. Photoelectric tri stimulus colorimeters have the capacity to do away with a number of the variables discovered whilst the visual technique is used completely and offer correct and repeatable measurements¹⁸.

Menopause is a regular developmental level in a woman's existence accompanied with a massive wide variety of signs starting from physical to psychological. A number of the common oral manifestations are an oral burning sensation with associated mucosal infections, ache, altered flavor perception, and alveolar bone loss. Those signs may additionally unfavorably affect oral health and remedy needs requiring dentists to plot newer techniques that could upload along to the remedy modalities counseled via gynecologists in relieving menopausal women from above symptoms¹⁹.

so innovate methods had been used to assist the menopausal edentulous female to sense hot/cold sensations of food/drinks, thereby giving them relief from ache, higher flavor notion, and remedy from related allergic and candida infections which are commonplace with conventional acrylic base dentures.

As the manner of addition of silver nanoparticles, it's far obvious that the degree of nanoparticles' dispersion within the PMMA matrix is affected by the chemical composition of this acrylic resin. Probable, at excessive concentrations, particle dispersion and chemical interactions among PMMA and AgNPs are low, ensuing in a decrease in tensile electricity. the speculation of this observe became that , to improve dispersion inside the acrylic resin, the AgNPs addition in a liquid form to heat-therapy acrylic resin could bring about extra homogenous mix and higher mechanical homes.

MATERIALS AND METHODS

The first part of this research was experimental study and conducted in Laboratory of Prosthodontic Department, Faculty of Dentistry, Tanta University. Two denture base materials were used, one of them was heat-polymerized polymethyl methacrylate (PMMA) (Acrostone (A), Anglo-Egyptian Company. Hegaz, Cairo, Egypt, Batch No.505/04) and the other was Nanoparticles of silver (NAg) (Nano Technology Co., Ltd., Egypt (Figure 1) added with concentration (0.2%, and 0.4%) to the heat-cured acrylic resin in two forms, powder additive form and liquid additive form. Twenty five specimens with 65 mm length, 10 mm width and 3 mm thickness for flexural strength (figure 2). and twenty five disc-shaped samples, with uniform size of 10 mm diameter and 2 mm in thickness for color stability were prepared according to ISO 1567 Standard²⁰ (figure 3). The samples for each test were divided according to the way and percentage of nanosilver addition to acrylic resin as were shown in table 1

Preparing samples of group 1 (control group without silver nanoparticles)

Five samples were prepared from heat cure acrylic resin. The acrylic paste was prepared considering manufacturer liquid/powder ratio supplied in powder and liquid forms. The amount of acrylic resin that needed for the five samples was counted and so on the weight of each sample could be estimated which was 0.4 gram (gr).

Preparing samples of group 2 A and B (Addition of Nanoparticles powder to the acrylic resin powder)²¹

The counted amount of 0.2 % and 0.4% weight of silver nanoparticles (gr) from 0.4 gr which is the sample weight is equal to 0.008 gr and 0.016 gr of silver nanoparticles powder with average size measuring 22 nm was mixed with heat-cure denture base acrylic powder (PMMA). The two powders were mixed in a mortar and then in an amalgamator (YDM, China) for two minutes to achieve a mixture with uniform color.

Preparing samples of group 3 A and B (Addition of Nanoparticles liquid to the acrylic resin liquid)²²

Silver nanoparticles were synthesized through the reduction of silver nitrate (AgNO_3) (Merck KGaA, Darmstadt, Hesse, Germany) with sodium citrate ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$) (Merck KGaA). The aqueous solution of silver nitrate and sodium citrate was kept at boiling temperature for a couple of minutes until the solution turned amber yellow, indicating the formation of colloidal silver nanoparticles, Finally, the solution was cooled in room temperature.

The weight of 1.5 cc silver nanoparticle colloid was 2 gr powders after concentration. The volume of silver nanoparticle colloids for sample preparation was evaluated considering weight percentage of silver nanoparticles in the acrylic samples which was used with powder additive is 0.008 and 0.016 gr for 0.2% and 0.4% for each sample respectively.



Fig. (1) Showed the Nano silver powder

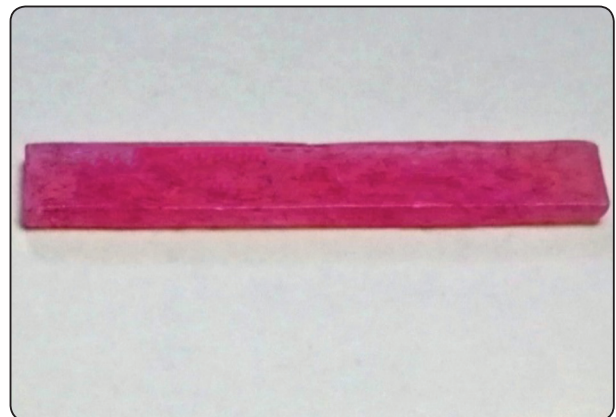


Fig. (2) Specimens of flexural strength



Fig. (3) Specimens for color measurements

TABLE (1) Showed the groups of sample

Group 1	Control group, acrylic resin without silver nanoparticles
Group2A	Nanosilver added to acrylic resin with 0.2 % in powder form
Group2B	Nanosilver added to acrylic resin with 0.4 % in powder form
Group3A	Nanosilver added to acrylic resin with 0.2 % in liquid form
Group3B	Nanosilver added to acrylic resin with 0.4 % in liquid form

The required volume of colloid for preparation of each acrylic samples containing 0.2% silver nanoparticles is equal to: $0.008 \text{ gr silver nanoparticles} \times (1.5 \text{ cc of silver nanoparticle colloids}) / (2 \text{ gr of silver nanoparticle colloids}) = 0.006 \text{ cc}$. Regarding the above-mentioned equations, the required volume of colloid for preparing one sample of 0.2wt% and 0.4 wt% (mass fraction) is 0.006 cc and 0.012 cc respectively .

Then, the powder and liquid with nanoparticles solution were mixed according to manufacture recommendation. The heat cured acrylic resin was processed; finished and polished. The samples for each test were scheduled according to the addition technique and additive percentage. All acrylic specimens were labeled and immersed in distilled water and stored at 37°C for 1-week.

One edentulous menopausal woman that undergoing treatment under a gynecologist for menopausal symptoms was selected as a case report and reported with the chief complaints of burning sensation in the oral cavity especially in anterior portion of mouth, frequent redness of mucosa, inability to sense temperature changes of food, and recurrent allergic and microbial infections with present acrylic dentures. Medical history revealed that the patient was undergoing treatment under a gynecologist for menopausal symptoms. Dental history revealed patient was edentulous

since 2 years and had been experiencing problems with current denture since 1 year. New complete denture constructed from silver nanoparticles added in liquid form with 0.2% to heat cure acrylic resin and patient satisfaction about the previous complain was evaluated after four months .

Measurement and analysis

Flexural analysis test²³

The flexural strengths of the specimens were determined using a 3-point bending testing device in a universal testing machine (Model LRX-plus; Lloyd Instruments Ltd., Fareham, UK) (Figure4) with a load cell of 5 kN and data were recorded using computer software (Nexygen-MT; Lloyd Instruments). The device consisted of a loading wedge and a pair of adjustable supporting wedges placed 50 mm apart .The specimens were centered on the device in such a way that the loading wedge, set to travel at a crosshead speed of 5 mm/min, engaged the center of the upper surface of the specimens. Specimens were loaded until fracture occurred.

The calculation of FS (MPa) was guided by the formulae:

$$FS = 3F (L)/2wh^2$$

Where; F is the maximum load at the point of fracture (N), L is the span (mm), w is the width of the sample (mm) and h its height (mm).

Color Assessment²⁴

A double beam ultra-violet visible spectrophotometer (UV-Vis. UV 3101 PC, Shimadzu scanning spectrophotometer) (Figure 5) was used. A sphere attachment was used for the measurement. The sample was hold in the attachment by a holder. (X, Y and Z) value was computed relative to the CIE 1931 Commission International L'Eclairage and relative to particular light source. The ratios of each value of a color to their sum are called

chromatically coordinate (x,y,z) i.e.:

$$x = X / (X+Y+Z)$$

$$y = Y / (X+Y+Z)$$

$$z = (1-[X+Y])$$

A CIE L^* , a^* and b^* color order system, provided a useful standardization technique for color difference assessment. Difference between two colors was determined from the color difference formula:

$\Delta E (L^*, a^* \text{ and } b^*) = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$ Where L^* , a^* and b^* depended on values (X,Y,Z) of the specimens and a perfectly white object where L^* corresponds to the value in the Munsell system which represents the lightness coordinate, while a^* is the red-green coordinate and b^* is the yellow-blue coordinate. The color of each opposing pair is indicated by the positive and negative values of a^* and b^* ($+a^*$ = redness, $-a^*$ =greenness, $+b^*$ =yellowness, $-b^*$ =blueness). The values (X+Y+Z), the chromatically coordinate (x,y,z). The L^* , a^* and b^* , ΔE , ΔL , Δa , and Δb were automatically calculated. The results were recorded with a computer color matching system (CCM).

Statistical analysis was performed by Statistical Package for Social Science (SPSS) computer software (SPSS 16.0, SPSS Inc., Chicago, USA).



Fig. (4) Universal testing machine



Fig. (5) Spectrophotometer

One-way ANOVA was used to determine whether significant differences existed between the means of the various experimental groups. Tukey test was employed at the chosen level of probability ($p < 0.05$) to determine if the means were significantly different from each other

RESULTS

As shown in table 2 graph 1, there were significant differences in the mean flexural strength values among all groups compared to the control group ($p < 0.05$). The results of multiple comparison tests for flexural strength of samples in all groups showed that, acrylic resin samples with 0.2% additive in liquid form (3A) resulted in more flexural strength than other groups followed by 0.4% liquid form addition (3B). While the addition of 0.4 % in powder form (2B) had a significantly lower flexural strength compared to the other groups.

As regards color difference as shown in table 3 graph 2, there was a significant difference ($P < 0.05$) between groups (1,2 and 3). In comparison to heat-cured acrylic resin without additives (non-modified control group), addition of nanoparticles of silver in liquid state to heat-cured acrylic resin with 0.2% (group 3A) showed lowest mean color differences (ΔE) followed by 0.4% (group 3B) Addition of

Nano silver in the form of powder by 0.4% (group 2B) resulted in highest color difference followed by 0.2% (group 2 A) .

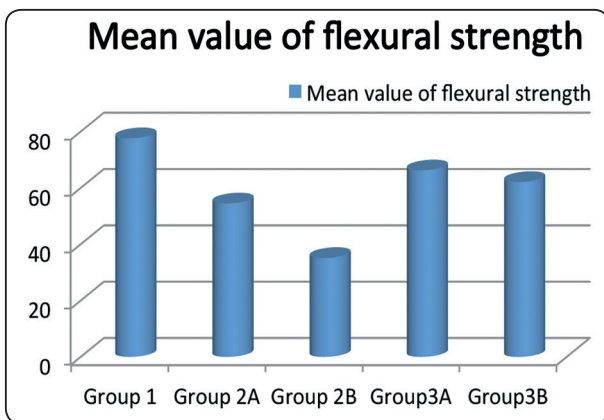
Satisfaction of menopausal woman

The patient received complete denture constructed from Nano silver added to heat cure with 0.2% in liquid form .As it was the nearest flexural strength and color difference comparable to unmodified heat cure. Patient reported relief of complained menopausal symptoms, as better awareness with hot and cold, no more redness and comfortable denture .

TABLE (2) Showed the means and standard deviations of flexural strengths of the tested groups (in MPa)

Group	Mean	SD	P
Group 1	77.63	7.90	0.000
Group 2A	52.4883	13.21	
Group 2B	35.1250	9.45	
Group 3A	66.230	4.208	
Group 3B	62.0983	12.98	

Statistically significant at p ≤ 0.05

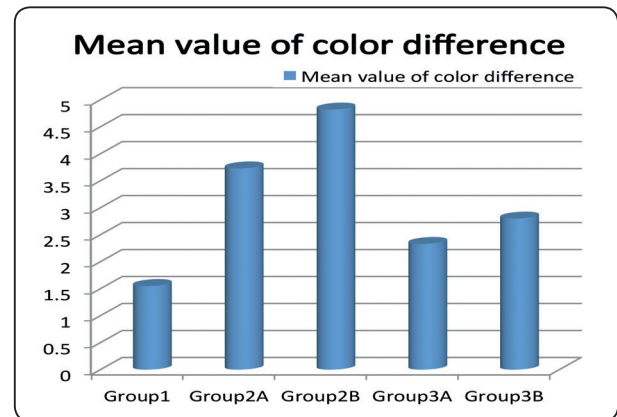


Graph (1) showed the means value of flexural strengths of the tested groups (in MPa)

TABLE (3) Showed the mean and standard deviation of color differences of acrylic resin with AgNps incorporation

Group	Mean	SD	P
Group1	1.55	0.29	0.000
Group2A	3.73	0.20	
Group2B	4.82	2.53	
Group3A	2.33	0.25	
Group3B	2.80	0.20	

Statistically significant at p ≤ 0.05



Graph (2) Showed the mean value of color differences of acrylic resin with AgNps incorporation

DISCUSSION

Many studies have tried to improve the houses of acrylic denture base through adding extraordinary materials. The use of silver as an additive due to its high thermal conductivity could enhance the low thermal conductivity of acrylic resin denture. Moreover, it's been validated that silver has no dangerous impact on oral mucosa and may even decrease the adhesion of candida albicans and exert antimicrobial effects¹⁰.

As said through Balan et al²⁵, for the coaching of Nano composites, approaches have been advanced either by mixing nanoparticles with the polymer or including nanoparticles to the monomer. In the

present study, the 2 different including methods have been evaluated²⁵.

The additive percentage of silver nanoparticles in this research was 0.2% and 0.4 % as the nanoparticles addition must be certainly quantified such that the amount used does not purpose damaging on the mechanical and thermal residences of the acrylic base of entire dentures²⁶. It revealed that the effect of AgNPs on the flexural strength of PMMA relied on numerous elements which include the type of acrylic resin and the attention of nanoparticles^{27,28}.

It's miles important that the content material of Nano additives is of vital importance, even in modified polymeric substances. The nature of those particles is associated with their size and crystal type. The multiplied floor vicinity in Nano-sized debris reasons extra powerful touch with microorganisms and subsequent stepped forward antimicrobial property²⁹. On this research, the size of used silver nanoparticles ranged from 10 to a hundred nm, as it has been demonstrated that larger fillers in addition lower the tensile and flexural power. In addition, in case of the usage of low concentrations, small particle sizes have to be selected for higher distribution among the PMMA particles³⁰.

Low concentration of silver might reduce material expenses and less monomer could be wanted while mixing with acrylic powder. Consequently, the mechanical properties of the polymer could now not be compromised²¹. Chladek et al ²⁷ reported that the mechanical and physical properties of the composite are influenced by using silver nanoparticle attention. Additionally they showed that mechanical properties of composites decreased through growing silver nanoparticles.

The outcomes of this study indicated that incorporation of AgNPs extensively reduced the flexural strength of PMMA in all studied group that is probably attributed to Nano-silver particle size. This could additionally promote the chances of void formation from entrapped air and moisture and incomplete wetting of the nanoparticles by using

resin. Therefore the net impact of embedding silver nanoparticles became to weaken the polymer. The results are in agreement with Solhi et al ³¹, Zukas, et al³² and Ghaffari et al³³.

Despite the extensive decrease in flexure strength with Nano silver addition, the maximum similar strength to control group became the samples wherein the addition become in liquid form and of percent 0.2% due to the distribution of particles is greater equal than if mixed in powder shape into acrylic powder. That is in agreement with Mahross and Baroudi ³⁴ and confrontation with the technique of Hamedirad et al⁶, as they displaying that, the proportional quantities of acrylic resin powder and Nano silver decided via weighting with a virtual scale were mixed together by an amalgamator to attain a homogenous combination of PMMA and Nano silver powder. The of percentage 0.2% become better than of percentage 0.4% as pronounced with Balan et al²⁵. The lower in mechanical properties at higher concentrations might be attributed to the attributed to the quality of dispersion of nanoparticles with different surface characteristics within the resin matrix²².

Chatterjee ³⁵ stated that, as the Ag mapping consequences showed growing, AgNPs content material ended in agglomeration of these nanoparticles and growing impurity motion of nanoparticles. Impurities or particulate agglomerate compounds act as pressure concentration centers within the matrix and unfavorably decrease mechanical properties of resin. Surely, unmodified nanoparticles or particles modified with polar or non-polar amine derivatives exhibit different effects within the resin matrix with an increase in concentration ³³.

The American Dental Association³⁶ recommends the use of the global de l'eclairage (cie l*, a* and b*) for the shade differential which represents the overall colour difference between the two measurements in cie l*, a* and b* colour space is considered to be a higher indicator for evaluating the color stability of dental materials³⁷.

All groups of heat-cured acrylic resin with an addition of nanoparticles of silver (Nag) showed coloration differences (ΔE) values higher than that control group (unmodified acryl). The 0.4% powder form nanoparticles of silver have considerably highest suggest color differences observed by way of 0.2% nanoparticles of silver then 0.2 and 0.4% nanoparticles liquid form of silver contained heat-cured acrylic resin.

The color difference values of ΔE between 0 and a pair of represent insensible color variations, while price inside the variety of 2 to a few constitute realistic color variations. The existing results used nanoparticles of silver (Nag) % due to the fact their large surface vicinity and small particle size ought to enable them to launch greater Ag ions at a low filler level. thereby lowering Ag nanoparticle concentration is higher for efficacy and shade stability³⁸, as the Ag ions within the resin agglomerated to shape nanoparticles that became a part of the resin that have an destructive effect on the acrylic resin properties as flexure strength and coloration stability³⁹.

It becomes vital that the dentist is equipped with appropriate communication capabilities other than specialty/technical competencies required for creating an entire denture. it became discovered in one of the studies that postmenopausal women have been now not aware of their periodontal health and the risks worried to their systemic fitness and therefore authors suggested growing taskforce comprising of periodontists, generalists, verbal exchange experts⁴⁰.

CONCLUSION

Adding Nano silver debris to PMMA ended in a lower in flexural energy and coloration balance ,addition of Nano silver particles in liquid shape became better than powder shape as regarding flexural strength and shade difference and the addition percentage of 0.2 became better than 0.4.

Menopausal delight become better and her complain become managed with the brand new denture. Similarly research is wanted to quantify the filler distribution inside the polymer matrix

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