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Effect of Zirconium Silicate Nanopowder Reinforcement on Some Mechanical and Physical Properties of Heat Cured Poly Methyl Methacrylate Denture Base Material

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Abstract

Background:

Polymethyl methacrylate PMMA is one of the most widely used materials in fabrication of prosthetic appliance. Although it has many advantages as good esthetic, fitness, easy of use and inexpensiveness but it has relatively unsatisfactory mechanical properties such as low flexural strength and impact strength and dimensional instability.

Aim of the Study:

The principle of this study was to estimate the effect of addition of surface treated (silanized) Zirconium silicate Nano fillers in percentages of 1% and 1.5% by wt of PMMA powder on the impact strength, transverse strength, surface hardness, surface roughness, water sorption and solubility of heat cured acrylic resin denture base material (PMMA).

Materials and methods:

Zirconium silicate nanoparticales were coated with a layer of trimethoxysilylpropylmethacrylate (TMSPM), Fourier transform infrared (FT-IR) confirmed that TMSPM was reacted with $ZrSiO_4$ nanofiller and copolymerized with PMMA. Then disseminated and sonicated in monomer (MMA) in the percentages 1% and 1.5% by weight then mixed with powder according to manufacturers instruction. (150) samples were prepared and divided into three groups each group consisted of (50) samples, one of them was prepared from PMMA without addition of nano filler (control), other groups experimental with the addition of 1% by wt $ZrSiO_4$ nanoparticles and the other with 1.5% by wt $ZrSiO_4$ nanoparticles. Each group was divided into 5 sub groups according to the test performed. The tests conducted were impact strength, transverse strength, indentation hardness (shore D), surface roughness, water sorption and solubility.

The size, shape and distribution of nanofillers were estimated using scanning electron microscope (SEM) .The results were statistically analyzed using ANOVA table and LSD test.

Results:

Highly significant increase in impact strength, transverse strength and surface hardness occurred with 1.5% by wt addition of Zirconium silicate nanofiller but no significant increase in impact strength, significant increase in transverse strength and highly significant increase in surface hardness occurred with 1% by wt addition of $ZrSiO_4$ nano filler. Non-significant increase in surface roughness with both 1% and 1.5% wt $ZrSiO_4$. Highly significant decrease in water sorption and solubility with 1.5% wt $ZrSiO_4$ nanofiller and non-significant decrease in water sorption and solubility with 1% wt $Zrsio_4$ compared with control group. SEM results showed a good distribution of the modified nano-$ZrSiO_4$ fillers at 1.5% wt in the polymer matrix.

Conclusion:

The addition of 1.5% by wt of modified nano-$ZrSiO_4$ to heat cured acrylic resin improved the impact strength, transverse strength and surface hardness of material, at the same time this addition decreased water sorption and solubility with a non-significantly increased in surface roughness was observed.