Evaluation of the effect of modified nano-fillers addition on some properties of heat cured acrylic resin denture base material

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Abstract

Statement of problem: The poly(methylmethacrylate) is the most reliable material for the construction of removable prosthodontic appliances but unfortunately, it has shown to be lacking two important properties which are strength and radio- opacity.

Purpose: The purpose of this study was to evaluate the effect of addition of modified nano-zirconium oxide (ZrO_2) on some properties of heat cure acrylic denture base material (PMMA) and to investigate the effact on radio-opacity.

Material and method: Zirconium oxide nanofillers were incorporated into polymethylmethacrylate denture base by free radical bulk polymerization. Zirconium oxide nanoparticales were coated with a layer of trimethoxysilypropylmethacrylate (TMSPM) before dispersed and sonicated in monomer (MMA) in different percentages 2%, 3%, 5% and 7% by weight. Then mixed with acrylic powder as general conventional method. Two hundred fifty five (255) specimens were prepared for this study they were divided into (6) groups according to the test used. The tests conducted were impact strength (sharpy tester), indentation hardness (shore D), surface roughness, transverse strength, radio-opacity and microscope test, for each test five subgroups (one control and four for nano-ZrO_2) where each subgroup contain ten specimens to be tested except for microscope test one specimen for each of five subgroup were taken , pure PMMA was used as blank control. The size and shape distribution of nano-ZrO_2 particles were estimated using scanning electron microscope (SEM) and atomic force microscope (AFM). The results were subjected to ANOVA and LSD test

Result: Infra red (IR) confirmed that TMSPM reacted with the nano-ZrO2 particals and copolymerized with PMMA. Significant increase in impact and transverse strength occur in acrylic reinforced with 3wt%, while highly

significant increase occur at 5wt%, but non significant increase was observed at 2wt%,also a non significant decrease at 7wt% when compared to control group. Non-significant increases in indentation hardness and surface roughness appear with addition of modified nano-ZrO_2 at different percentages. For radio-opacity a highly significant increase had occurred with the addition of modified nano-ZrO_2. SEM and AFM results showed a good distribution of the modified nano-ZrO_2 fillers at 5wt%, and showed aggregation at 7wt% in the polymer matrix

Conclusion: The addition of modified nano-ZrO_2 particles highly increase the radio-opacity of heat cure acrylic (PMMA), this increase was proportional to the concentration of nano-ZrO_2. The maximum increase in impact and transverse strength was observed in denture base nano composite containing 5wt% of nano-ZrO_2, and this strength decreases with further increase of nano-ZrO_2 filler content. Also addition of modified nano-ZrO_2 slightly increases the indentation hardness and no change in surface roughness was observed.