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The Effect of Incorporating Chitosan Nanoparticles On Surface Roughness and Hardness Of Heatcure Denture Base Acrylic Resins: An Invitro Study.

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ABSTRACT

Background:Chitosan nanoparticles have been considered as an attractive compound in the biomedical field including wound dressings, prolonged or controlled-release drug delivery systems, and blood anticoagulants. Chitosan is a mucoadhesive biocompatible polymer that is also a defense elicitor and an antimicrobial agent which is approved by U.S. FDA for tissue engineering and drug delivery. It has interesting properties such as biodegradability, bioactivity, nontoxicity, and polycationic nature. Chitosan is a family of molecules with differences in their composition, size, and monomer distribution. These properties of Chitosan can create fundamental effects on the biological and technological properties of the denture base polymers.

Aim:The study aims to assess the effect on surface roughness and hardness of heat-cure acrylic resin when reinforced with chitosan nanoparticles.

Material And Methods: A total of 40 acrylic cylindrical specimens with a standardized size were made, among which 20 samples were made by incorporating chitosan. A total sample size of 40 was taken among them 2 groups of A & B denote surface roughness and hardness containing a sample of 20 each. Each group contains 2 subgroups with a sample size of 10.Hardness was measured using a Vickers hardness tester using a 100 –gf load, The surface roughness was measured using a profilometer

Results:The surface roughness and hardness were tested for both groups. Adding chitosan nanoparticles to heat-cured acrylic resin increased the microhardness and decreased surface roughness.

Conclusion:

Adding chitosan nanoparticles to heat-cured acrylic resin increased the microhardness and decreased surface roughness.

KEYWORDS: Acrylic, Nanomaterials, chitosan, surface roughness, hardness.

I.INTRODUCTION

[1]. Heat-polymerized acrylic resin has been the most commonly used denture base material for over 60 years. However, the hardness and surface roughness of Polymethyl methacrylate (PMMA) is not adequate for the long-term clinical performance of dentures. Therefore, the fracture is a common clinical occurrence, which is often seen in the midline of the denture base. The fabrication of a new denture is time-consuming and costly for patients, denture repair is the only alternative.

[2]. Studies showed that the incorporation of chitosan nanoparticles into PMMA improved its surface roughness.

[1]. Chitosan is a polysaccharide biopolymer obtained from the deacetylation of chitin and is also non-toxic, biocompatible, and biodegradable. It has been demonstrated that chitosan can aid in surface roughness.

[5]. So, the incorporation of reinforcing materials into the PMMA not only improves the hardness but also saves the chairside time and they do not require laboratory processing; moreover, the patient spends less time without dentures during the repair process. Hence the significance of the study.

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II.MATERIALS AND METHODOLOGY:

Materials and armamentarium:

Heat cure acrylic resin and liquid, Cold mold seal, Demineralized water, Acetic acid glacial, Chitosan nanoparticles, and Dental plaster

Equipment used:

Glass beaker, Digital weigh machine, Magnetic stirrer, Denture flask, Vibrator, Hydraulic press, Dental acrylizer, Vickers hardness tester, and Profilometer.

SAMPLE SIZE:

Total sample size = 40
(2 groups of A & B denote surface roughness and hardness containing a sample of 20 each)
Each group contains 2 subgroups with a sample size of 10 in each.

Group A1: Control to evaluate surface roughness
Group A2: Chitosan-infused heat cure acrylic resin to evaluate surface roughness
Group B1: control to evaluate the hardness
Group B2: Chitosan-infused heat cure acrylic resin to evaluate the hardness

1)GROUP A1:

To produce cylindrical specimens with a standardized size, a metal casting mold (a rectangular shape (65 x 10 x 2.5 mm) according to the American Dental Association specification no. 12. was used, and PMMA will be packed into the mold space. Heat-polymerized specimens were polymerized by using conventional flasking(figure 1) and inserting the flask in a boiling water bath for 30 minutes at 100°C. After packing (figure 2), acrylization will be done.
To standardize and simulate denture roughness at the palatal site, all specimens were prepared first with 800-grid, followed by 1200-grid, sandpaper (Struers SiC Foil #800 and #1200, Struers RotoPol-22, Struers GmbH, Copenhagen, Denmark). [1]

figure 1:&2 Flasking, dewaxing, and acrylisation done

2)GROUP A2:

To produce cylindrical specimens with a standardized size, a metal casting mold (a rectangular shape (65 x 10 x 2.5 mm) according to the American Dental Association specification no. 12. was used. Chitosan-infused PMMA will be packed into the mold space.

The infusion of chitosan nanoparticles into the PMMA will be attained by the following procedure:299ml of distilled water will be added to a 500 ml glass beaker and 1 ml of glacial acetic acid and distilled water will be dispensed and mixed (300 ml of 1 percent acetic acid). 6g of chitosan powder will be measured using the digital weighing machine and will be incorporated for dissolving using a magnetic stirrer for 24 hours.20 g PMMA will be mixed with 10 ml of dissolved chitosan in a porcelain jar till a wet sandy stage is attained .10 ml of liquid monomer will be added to the jar and manipulated till the dough stage. After packing, acrylization will be done. Roughness is induced similarly to group A1.

3)GROUP B1:

10 PMMA samples will be made similar to Group A1. Roughness is not induced with sandpaper.

3)GROUP B2:

10 PMMA samples will be made similar to Group A2. Roughness is not induced with sandpaper.

III.TESTING OF SPECIMEN:

Hardness will be measured using a Vickers hardness (figure 4&5) tester using a 100 –gf load
The surface roughness will be measured using a surface profilometer (figure 3)

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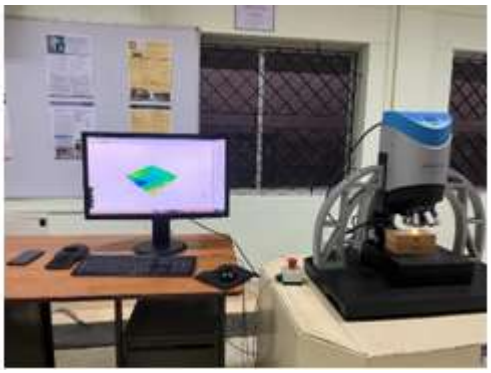

Figure 3 :surface profilometr

Figures 4 &5 : Vickers hardness tester

IV. STATISTICAL ANALYSIS:

Data was analyzed using the statistical package **SPSS 26.0** (SPSS Inc., Chicago, IL) and level of significance was set at **p<0.05**. **Descriptive statistics** was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using **Shapiro Wilkinson test**. **Inferential statistics** to find out the difference between the group was done using **INDEPENDENT T TEST**

TABLE 1- COMPARISON OF HARDNESS

	MEAN	SD	P Value (T test)
PMMA WITH CHITOSAN	**22.1**	**0.91**	**0.0001* (Z=8.661)**
PMMA WITHOUT CHITOSAN	**19.57**	**0.23**	

*P<0.05 is statistically significant (Shapiro Wilkinson test, P>0.05)

Comparison of 'HARDNESS' between the groups was done using two tailed INDEPENDENT T-test and reported a statistically significant lower mean value concerning PMMA with the CHITOSAN group (p<0.05)

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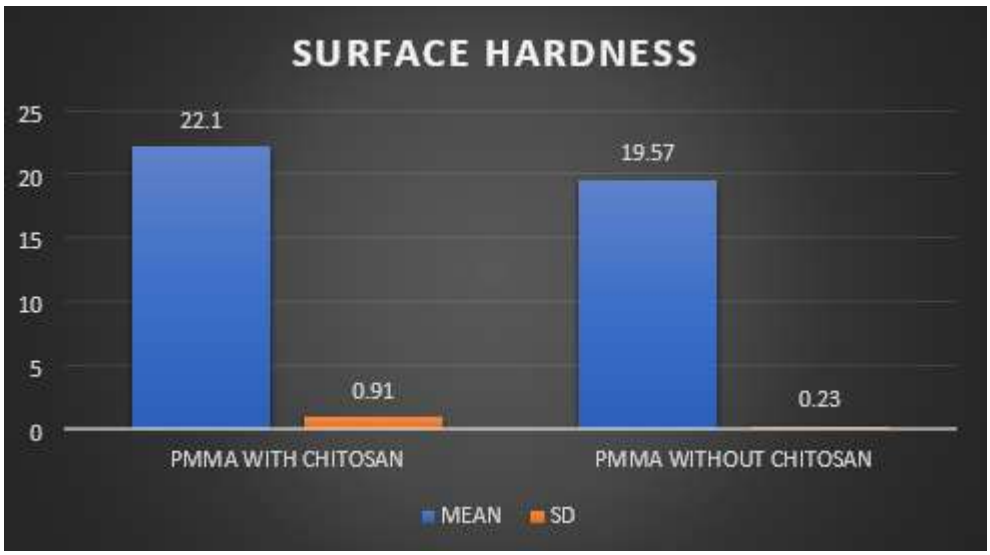
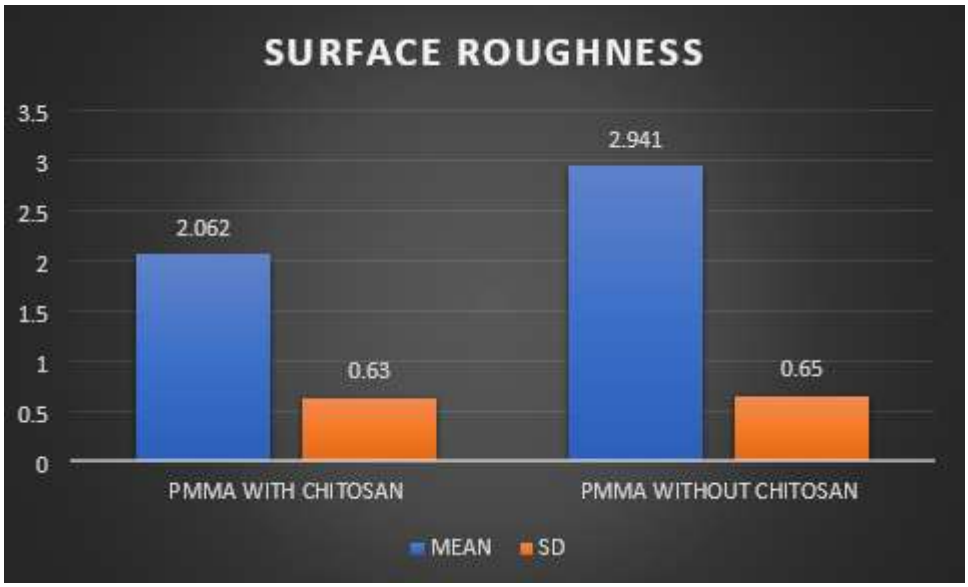


TABLE 2- COMPARISON OF SURFACE ROUGHNESS

	MEAN	SD	P Value (T test)
PMMA WITH CHITOSAN	**2.062**	**0.63**	**0.008* (Z=2.96)**
PMMA WITHOUT CHITOSAN	**2.941**	**0.65**	

*P<0.05 is statistically significant (Shapiro Wilkinson test,P>0.05)
Comparison of 'SURFACE ROUGHNESS' between the groups was done using a two-tailed INDEPENDENT T-test and reported a statistically significant lower mean value concerning PMMA with the CHITOSAN group (p<0.05)



DURATION OF STUDY:6 month.

V . CONCLUSION:

From the experimental results of the incorporation of chitosan Nanoparticles with heat cure acrylic resin it was concluded that:

1. Considering the limitations of this in vitro study, our data support that adding 10 ML of dissolved chitosan nanoparticles to heat-cured acrylic resin

increased the microhardness and decreased surface roughness without adverse effects on their physicomechanical properties.

2. These results indicate that the addition of chitosan nanoparticles to PMMA can increase the surface smoothness and can increase the hardness further support to this study will be taken after comparing the flexural strength, which will be done along with an upcoming study.
3. This research focuses on the development of materials used for manufacturing prosthetics as well as the need to provide new materials that are low-cost and eco-friendly for prosthesis components.

Future development of prosthodontics technology has been recognized to be dependent on the progress of materials science. Nanomaterials have been playing a significant role in basic scientific innovation and clinical technological change in prosthodontics thus evident through this short study.

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