Original Article

Assessing The Outcomes Of Aluminium Oxide On Surface Roughness And Flexural Strength Of Heat Cure Denture Base Resin

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Abstract

Background and aim: Frequent fractures are seen with denture bases made of acrylic owing to their poor strength. Also, another vital property of the denture base is the surface roughness as rough surface leads to accumulation of the food particles which further lead to plaque retention. The microorganisms are seen predominantly inhabiting the surface and in this plaque are candida species mainly C. Albicans. The present study was conducted to assess the outcomes of aluminium oxide on surface roughness and flexural strength of heat cure denture base resin.

Materials and Methods: The study comprised of two groups of heat cure denture base resin having 15 wt.% aluminium oxide and conventional heat cure denture resin base. For the study, ISO standard size mould was made with brass rectangle investing in the dimensions of 65 mm × 10 mm × 3 mm. 30 specimens were made and were divided into 2 groups of 15 subjects each where Group I was controlling group where no aluminium oxide was added and Group II was experimental with 15 wits% of aluminium oxide. Specimens were then stored for 14 days followed by measurement of flexural strength using 3 points bending test and a profilometer was used to assess the surface roughness.

Results: The study results showed that the addition of 15wt% aluminium oxide shows significantly better surface roughness and flexural strength compared to the heat-cured conventional denture base resin.

Keywords: Aluminium oxide, denture base resin, flexural strength, surface roughness

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INTRODUCTION

The most commonly used material for denture fabrication is PMMA (Polymethyl methacrylate). Despite being the most common denture fabricating material, it does not fulfil the requirements of being an ideal material for denture fabrication. The mechanical properties of the denture base materials are attempted to increase in various ways including copolymerization with rubber, the addition of crosslinking agents to modify the chemical structure, inclusion of fibres, and mechanical reinforcement of acrylic through metal inserts.1

One biocompatible method employed is a reinforcement of the ceramic particles which has added advantages of restoring the aesthetics in the denture. Also, another vital property of the denture base is the surface roughness as rough surface leads to accumulation of the food particles which further lead to plaque retention. The microorganisms are seen predominantly inhabiting the surface and in this plaque are candida species mainly C. Albicans.2

The previous literature data depicts that incorporation of the aluminium oxide in low concentration to the denture base material shows high strength of the acrylic resin. However, its effect on surface roughness is not evaluated by any previous study.3 The present study was conducted to assess the outcomes of aluminium oxide on surface roughness and flexural strength of heat cure denture base resin.

Materials and Methods

The specimens were prepared using ISO standard size mould and were made with brass rectangle investing in the dimensions of 65 mm × 10 mm × 3 mm. The matrix was comprised of conventional heat-cured resin and the powder of aluminium oxide as a reinforcing agent with the size of 50 μm. The specimens of acrylic were made by acrylic resin packing into the moulds of stones that were contained in the denture flask and cured at 70°C for 1.5 hours. This was followed by deflasking. After deflasking, the specimens were trimmed and ground with silicon carbide paper to attain a polished surface. 30 specimens were made and were divided into 2 groups of 15 subjects each where Group I was the control group where no aluminium oxide was added and Group II was experimental with 15 wt.% of aluminium oxide. To get a uniform mixture, a powder of aluminium oxide was mixed with the liquid monomer and resin powder. Resin powder was mixed with aluminium oxide and monomer and in the closed lid mixing jar.

The flexural strength was tested after deflasking the rectangular specimens. After deflasking, the edges were polished and trimmed. Before testing the flexural strength, Vernier calliper were used to measure the dimensions of each specimen. Specimens were then stored for 14 days in the distilled water followed by measurement of flexural strength using 3 points bending test. To assess the flexural strength, specimens were placed in the device centre in a manner that the loading wedge will travel at speed of 5mm/min crosshead. The specimens were engaged at the upper specimen surface in the centre. The loading was done unless a complete fracture was seen. For assessing the flexural strength, the formula used was FS=3P/2bd2 where P was the maximum load at the point of fracture, d was the Depth or thickness of the specimen (mm) b was the Width of the specimen, and I was the distance between the supporting wedges.

For testing the surface roughness, following deflasking, the specimens were seen to evaluate the surface smoothness without porosity and voids. This was followed by polishing of specimens using silicon carbide papers. The surface roughness was evaluated using a profilometer (contact-type) AFM (atomic force microscope). For this, the probe of the profilometer interacted with the substrate in a raster scanning motion. Atomic force microscope works on the principle that attachment of tip to small cantilever forms a spring, and on the contact of the surface to the tip, cantilever bends and detection of the bending is done with a split photodetector and laser diode. The bending indicates tip-sample interaction force. While in contact, the tip is pressed against the surface and a feedback loop monitors the interaction force of the tip and sample to keep the constant deflection during the raster scanning. The laser beam reflection is assessed using a position-sensitive photodetector that increases lateral and vertical probe motion.

The collected data were subjected to the statistical evaluation using SPSS software version 21 (Chicago, IL, USA) for results formulation. The data were expressed in percentage and number, and mean and standard deviation. The level of significance was kept at $p<0.05$.

Results

The present study was conducted to assess the outcomes of aluminium oxide on surface roughness and flexural strength of heat cure denture base resin. The study comprised of two groups of heat cure denture base resin having 15 wt.% aluminium oxide and conventional heat cure denture resin base. For the study, ISO standard size mould was made with brass rectangle investing in the dimensions of 65 mm × 10 mm × 3 mm. 30 specimens were made and were divided into 2 groups of 15 subjects each where Group I was controlling group where no aluminium oxide was added and Group II was experimental with 15 wt.% of aluminium oxide. Specimens were then stored for 14 days followed by measurement of flexural strength using 3 points bending test and a profilometer was used to assess the surface roughness.

On assessing the flexural strength in the two groups of the study subjects using polymethyl methacrylate with aluminium oxide and polymethylmethacrylate alone, it was seen that the flexural strength in PMMA with aluminium oxide was 79.33±2.04 which was significantly higher than the flexural strength of PMMA alone, which was 77.32±2.47. This difference was statistically significant with $p<0.001$ as shown in Table 1.

Concerning the surface roughness assessment in the two groups of the study subjects, it was seen that surface roughness was significantly higher for the group where aluminium oxide was added to polymethylmethacrylate with the value of 416.37±1.75 compared to the group where polymethylmethacrylate was used alone as the denture base resin with the value of 153.529±2.34. This difference was statistically significant between the two groups with a p-value of <0.001 as depicted in Table 2.

Discussion

The present study was conducted to assess the outcomes of aluminium oxide on surface roughness and flexural strength of heat cure denture base resin. The study comprised of two groups of heat cure denture base resin having 15 wt.% aluminium oxide and conventional heat cure denture resin base. The study results showed that incorporation of aluminium oxide to the denture base resin of polymethylmethacrylate results in better surface roughness and flexural strength compared to the denture resin base made of polymethylmethacrylate alone. These results were comparable to the studies of Abdul M et al4 in 2015 and Ellakwa AE et al5 in 2008 where authors reported that better denture base material is polymethylmethacrylate with additive aluminium oxide.

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Conclusion

Within its limitations, the present study concludes that significant changes are seen in surface roughness and flexural strength of heat-cure denture base resin after the addition of aluminium oxide as the filler material leading to the significant increase in surface roughness and flexural strength. However, the present study had a few limitations including a smaller sample size, geographical area biases, and single-institution nature. Hence, more studies in vivo are warranted to reach a definitive conclusion.

Conflict of Interest

None

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Table 1: Assessment of the flexural strength in the two groups of the study subjects

S. No	Parameters	Number (n)	Mean± S. D	p-value
	PMMA with aluminium oxide	15	79.33±2.04	<0.001
	PMMA	15	77.32±2.47	

Table 2: Assessment of the surface roughness in the two groups of the study subjects

S. No	Parameters	Number (n)	Mean± S. D	p-value
	PMMA with aluminium oxide	15	416.37±1.75	<0.001
	PMMA	15	153.529±2.34	