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Influence of Optiglaze Material on Wear Resistance of Thermoplastic Resin

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Abstract

Statement of problem: The wear resistance for flexible denture base material.

Purpose: The purpose of the study was to measure the wear resistance, of flexible acrylic denture base material; after being coated with light-polymerized glaze material.

Materials and methods: A total of (30) Thermoplastic resin specimens were divided into three groups according to the tests, each group consisted of 10 specimens (A) control group had no surface treatment, group (B) specimens surface was treated with Optiglaze materials after finishing and polishing; group (C) specimens was treated with Optiglaze materials after finishing only without polishing. Each specimen's weight loss was measured by comparing the weights before and after the wear test. Collected data were statistically analyzed using SPSS**.**

Results: The results of this study showed the higher mean values for wear resistance was registered by (C) group which was 8.7420,followed by (B) group which was 7.3210,while the lowest mean value related to the (A) group which was 7.0907.

Conclusion: Statistically wear values were lower for groups C & D and higher in group A.

Clinical implications: This study may be useful in assisting dental professionals and technicians in selecting the best polishing and coating material for dentures. Coating flexible acrylic resin denture materials with an Optiglaze to improve wear resistance.

Keywords : Optiglaze ; Thermoplastic ; wear resistan.

Introduction

Tooth loss, which may result from many factors such as dental problem, direct trauma, missed tooth replacement is very essential for returning the weakness and recovering the function at optimum levels (1). In dental technology, the invention of resins has been a huge step. In1936, the first thermo polymerizable acrylic resins were created. Acrylic resins are also referred to Poly methyl methacrylate or PMMA. During an initial plastic phase, these synthetic materials are molded, packed, or injected into molds that solidify via a chemical reaction called polymerization (2). In the 1950s, flexible denture base materials known as Valplast and Flexiplast were introduced to dentistry. The injection molding process is used to create different prostheses types from such a material and fluid resin (3). The flexite denture is a type of elastic nylon partial denture resin, which has more flexibility than plastic one. Due to its attachment to gums, no clasps are required, making it more comfortable for the patient to wear in flexite-constructed complete and partial dentures. The polymethyl methacrylate was utilized in dentistry for many years as temporary crowns and thermal polymerized crowns (4). In partially edentulous patients, a flexible denture is a good alternative to a conventional denture, that provides a good aesthetic, security and adjusts to a persistent elasticity and movement (5). Thermoplastic nylon is a diamine and dibasic acid monomer-based polyamidic resin. Nylon is a versatile material that may be used in a variety of ways. Nylon is extremely flexible, strong, and resistant to heat and chemicals. Due to its excellent strength combination, heat-resistance, ductility, nylon is a strong contender for applications of metal replacements (2). It is difficult to polish and adjust thermoplastic resin, however, resins may be semi-translucent and allows good esthetic (4).The glazing composite sealant was introduced, with various benefits claimed such as; minimized clinical times; simple accesses and administrations; high polymeric conversion rates; improved wear, staining, plaque formation resistance; and the possibility to accomplish glazed restoration with fewer clinical procedures (6). The major aim of the current study was the evaluation of the wear resistance of thermoplastic nylon resin after painting with an Optiglaze material.

Materials and method

Preparation of samples.

A silicon mold was prepared using a machined stainless steel ring (30mm) in diameter and (25mm) height with stainless steel cylinder which was fabricated to be (10mm) in diameter and (20mm) height, the larger part (stainless steel ring) fix on glass slab and the small part (stainless steel cylinder) fix on glass slab inside the ring, then additional silicon material poured inside the ring over the cylinder and left for curing for (6 hours). After that, the separated small part cylinder from the larger part ring produced the silicon mold which constructed the wax pattern of the samples. The dimensions of the mold were (20mm) in length and (10mm) diameter according to the test device requirement (Fig 1) (7).

Wax Pattern Fabrication.

Wax pattern 20×10 mm length,

diameter, in dimensions was prepared by using silicon mold and base plate wax materials. The base plat wax was melted and then added incrementally in to the mold by using Lacron carver instrument drop by drop technique, the waxing procedure continued until the melted wax filled the mold and became 20×10 mm in length and diameter, then left to set. After completely set the wax pattern inside the silicon mold, was carefully removed from the mold.

Investing and spruing.

Cylindrical wax patterns were invested in the injection molding flask, by using dental stone type 3, the lower half of the flask has been filled with stones which have been mixed in accordance with the manufacturer's guidelines (33 ml water/100gm powder), then the sprue with modeling wax was placed in a such a way that each pattern was attached with the sprue so that injected material can seep into the space of each mold (8). The separating medium was applied to the stone after it had reached its setting time, the upper part of the flask was placed on the lower part, and a second mix of dental stone was placed into the flask and held under the hydraulic press. After the stone had been set, the wax was removed by immersing the flask in hot water for 5 minutes. The flask was then opened and rinsed with hot water to remove any residual wax. After cooling, the flask was reopened, and the separating media was applied to the surface of the mold (9).

Injection flexible resin materials.

The cartridge of flexible denture base resin has been placed in a heating unit and heated in accordance with the manufacturer's guidelines (300°C for 20 minutes) before being placed on the flask. The bench press was used to provide pressure to the cartridge, causing the material to enter into the space of the mold through the sprue. Following processing, the flask has been left to cool on a bench for 2 hours.

Finishing and polishing

The sprue of the sample was removed by a cutting -off disc with low pressure and continuous cooling by water to prevent overheating of the resin material. The margins of the sample were trimmed by agrinding wheel. All the 30 samples were finished by hand with a fine grade of silicon carbides paper (grades 120 to 500) and stone burs and sand paper sheet, with continuous cooling with water. Overheating of the sample must be avoided through the finishing processes. While only 20 of the specimens were polished using pumice and bristle brush using a dental lathe polishing machine at a low speed (1500rpm) and the samples were moved against the rag wheel with minimal pressure in only one direction, the final glossy surface was achieved by the dental lathe, with a wool brush and polishing soap, then cooling the specimens with water to avoid overheating during polishing and to prevent distortion of the specimens (10, 11). With light manual pressure, the abrasive paper was employed on 20 specimens. On the polishing lathe, medium grit and fine grit pumice mixed with water in a 1:1 ratio were applied respectively to a cloth wheel of 12.5 mm for 60 sec. at 3000 RPM. After that, the second cloth wheel with a high shine buff was utilized with polishing brown Tripoli. A grinder polisher machine was used to modify the surface of specimens and the specimens were immersed in distilled water at room temperature in accordance with ADA .specification No 12.

Surface treatment (Application

Optiglaze Materials).

All specimens were treated with Optiglaze Color (GC Corporation, Tokyo, Japan) in accordance with the manufacturer's guidelines. The specimens were polymerized for 90 seconds in a Labo-light Duo (GC) indirect composite light oven., (12).

Specimens grouping.

A total of 30 thermoplastic resin specimens were categorized into 3 groups, each group contained (10) specimens, in accordance with the surface treatment that had been applied:

Group A: 10 cylindrical shape flexible acrylic specimens were left without treatment (control group).

Group B: 10 cylindrical shape flexible acrylic specimens were treated with Optiglazing materials after finishing and polishing.

Group C: 10 cylindrical shape flexible acrylic specimens were treated with Optiglazing materials after finishing only without polishing.

Wear rate test.

Before testing, the specimens have been kept in distilled water for 48 hrs. A special device was utilized for wear testing, which was designed in the University of Technology, Dept. of Material Engineering and Resistance Laboratory, Iraq, called the device of pin on disk wear testing. It was made up of a pin that held specimens and a disk made of stainless steel wheel that rotates at (950 R/Min.). Before and after testing procedure, the specimen was weighed, the specimen was fixed to the holder, and a 10N load was applied to the horizontal arm, the wear testing time was 10 minutes. The distance between the specimen's center and the disk's center was 65 mm. The wear resistance was calculated using the following equation: Wear resistance (gm/mm) = change in the weight/slide distance (slide distance = 2π×radius distance between the disc's center and the specimen X No. of cycles X testing time). After each test, the disk was cleaned. (7).

Measurement of worn weight loss.

An electric balance (0.0001 g accuracy) (SPB31, Scaltec, Göttingen, Germany) was used to measure each specimen's weight (mg) before and after the wear's test. The difference in weight before and after wear testing was the weight loss of each specimen. The mean weights were obtained by taking the average of 3 readings for each specimen (13).

Results

Wear resistance test

The descriptive statistics which include (Mean values, stander deviation, stander error, maximum and minimum values) of the wear resistance test are presented in table 1 and fig 3. The results showed that the higher mean values for wear resistance were registered by (C group) which was (8.7420), followed by (B group) which was (7.3210), whereas the lowest mean value (7.0907), was related to the (A group).

The ANOVA test between groups of wear resistance test was showing significant P-value ≤ 0.05 with F test (4.001), as shown in table 2.

LSD test was used to examine the source of the difference between test groups as shown in table 3.

In table 3 the LSD test result showed a non-significant difference (P≥0.05) between group A (controls) and group B (finishing and polishing with glaze). While a highly significant difference

($p \leq 0.01$) between group A (controls) and group C (finishing with glaze), also a significant difference ($p \leq 0.05$) was found between group B (finishing and polishing with glaze) and group C (finishing with glaze).

Discussion

For more than a decade, the light-cured acrylic resin glaze was used (12). The use of this glaze in dental laboratories reduced the finishing operation to a reasonably simple procedure. Before insertion of the prosthetic appliances into the patient's mouth, the polishing procedure is essential to promote patient comfort and longevity of the restorations(14, 15). It also reduces the porosity of the surface, roughness, prevents microleakage, and increases acrylic resin stain resistance (14-16).The results shown by the descriptive statistics and the bar chart results revealed that the resistant wear level of groups (B, C) were higher than group (A), Statistically wear value wasn't observed in any thermoplastic resin specimen treated with the optiglaze groups (b, c), respectively in comparison with group A. One of the most important factors affecting the denture is whether it is worn in the patient's mouth during function or during the cleaning procedure. Since abrasion causes wear, so, the surface hardness is a significant feature that may be improved via glaze application to a surface (15, 17).Hardness is an intrinsic physical feature that refers to the resistance of a material to permanent deformation. It's also the most common mechanical property for describing a material's wear resistances. Wear resistances is considered to be higher for materials with a higher surface hardness (18). The polishing technique also influences on the hardness of acrylic resins, which would be significantly decreased when irregularities are present (scratches).Our findings contradict the study of Thompson & Luos reported that using the visible light-polymerized surfaces sealer had no effect on micro hardness or flexural strength (19).Titanium dioxide (TiO_2) is one form of nanoparticles found in the composition of Optiglaze. These nanoparticles are frequently used as inorganic reinforcement particles in dental polymer-based materials for improving mechanical characteristics and stimulate chemical inter-facial interactions among phases (20, 21). The TiO_2 and SiO_2 are utilized as photo polymerization initiator, resulting in super hydrophilic surface for self-cleaning material. Adding TiO_2 to resins, in particular, has been found to drastically improve their performance, including increased elastic modulus and hardness(21). In the current study, coated specimens were observed. TiO_2 nanoparticles have also been shown to form a strong connection between organic and inorganic phases of thermoplastic resin. Polished acrylic resin surfaces are often preferred because they are less prone to development of bacterial plaque and colonization. The result of this study is based on the concept that the unglazed surface of the denture causes plaque attachment. A glaze material may preserve the surface of the acrylic resin against disinfectant solutions (22).

Conclusions

Painting specimens with an Optiglaze material reduced wear values. Moreover Optiglaze color proved to be an appreciated tool in gaining polished surface and decreasing surface roughness rate. It was likely to obtain a polished surface using only the Optiglaze color finishing.

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Table (1): Descriptive statistics of wear resistance groups.

Descriptive statistics						
Wear resistance	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
control	10	7.0907	1.27323	.40263	5.16	8.51
finishing and polishing with glaze	10	7.3210	1.94759	.61588	4.64	9.54
finishing with glaze	10	8.7420	.76375	.24152	7.22	9.80

Table (2): ANOVA test between groups of wear resistance.

Studies groups	Mean Square	F	Sig.
Between Groups	7.998	4.001	0.03
Within Groups	1.999		

Table (3): LSD test among (A, B, C) groups.

Studied groups		Sig
control	finishing and polishing with glaze	0.71
	finishing with glaze	0.01
finishing and polishing with glaze	finishing with glaze	0.03

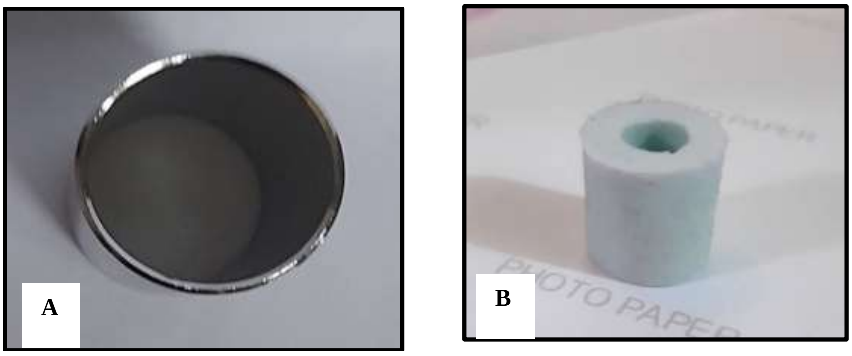

Figure (1): A- Stainless steel ring. B-Custom made cylindrical silicone mold.

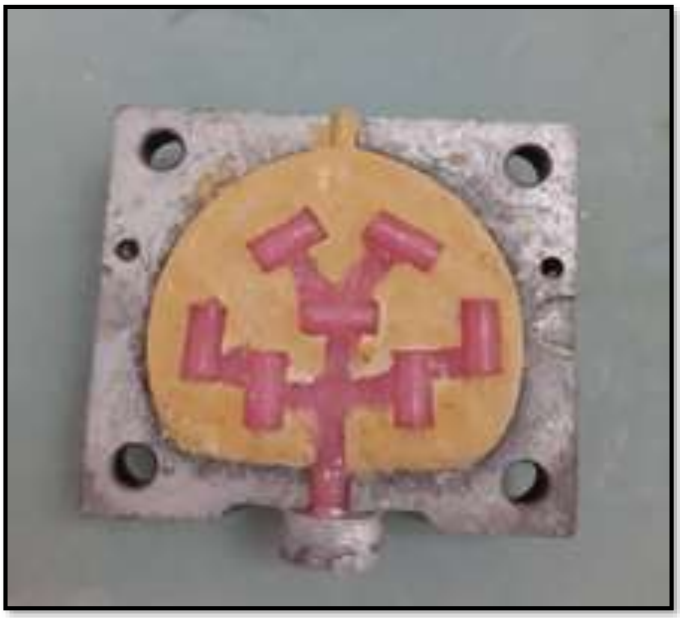

Figure (2): flexible resin materials after injection

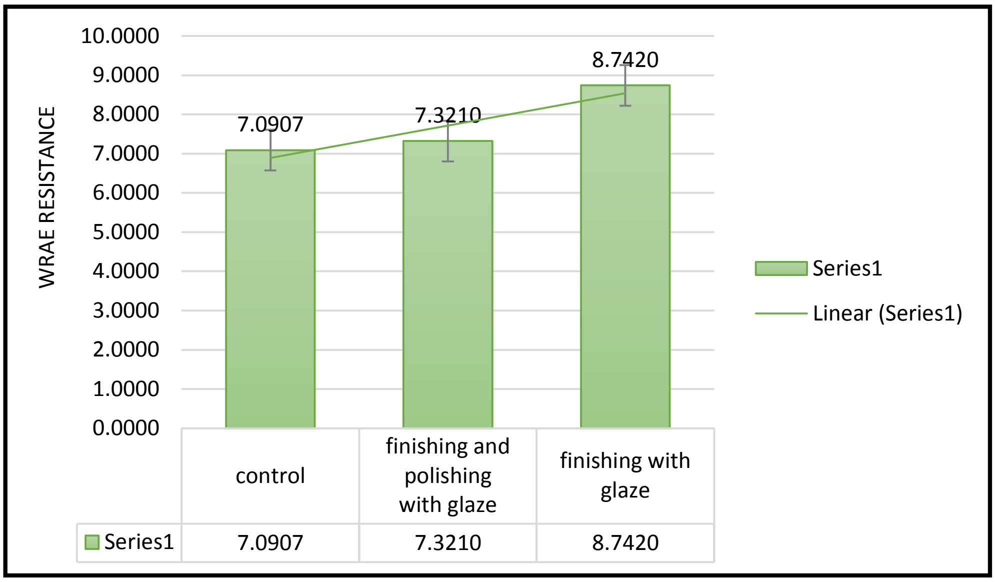

Figure (3): Bar chart the mean distributions of wear resistance test among control, finishing and polishing with glaze, and finishing with glaze.