The effect of adding micro zinc oxide filler to heat-polymerizing acrylic resin on some physical properties

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Abstract

Statement of problem: In dentistry, the acrylic resins are the common materials used for fabrication of removable dentures to restore function, appearance, etc. However, such restorative substances have to be lacking some physical properties. The aim of the current study to assess the effect of zinc oxide filler on some physical properties of heat cured acrylic resin. A total of 40 acrylic specimens were fabricated. Depending on the type of test, they were divided into water sorption and porosity groups. For each group, 20 specimens were reinforced with zinc oxide particles at 1% by weight and the others were considered as control. The porosity and water sorption tests were carried out for each specimen. The specimen's data were analyzed and comparison was made by independent t test. The results showed that there was a slightly reduction in water sorption and porosity after incorporation of zinc oxide filler. In conclusion; the addition of ZnO powder to heat cured acrylic resins affects slightly their physical properties.

Keywords: Zinc oxide; Acrylic; Porosity; Water sorption

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Introduction

Acrylic resins (i.e. heat cured acrylic resin) are the restorative substances which used as denture base material since 1940s [1, 2]. These materials are usually cheap and easy to manipulate by dental technician [3, 4]. They can restore patients' function, appearance and psyche [5, 6]. In spite of the desirable properties, they have some disadvantages such as poor strength and dimensional changes [7]. To overcome such problems several efforts have been carried out by incorporating various metal oxides such as Silicone dioxide and Zirconium Oxide. It was found in the literature that these additives have the ability to enhance the acrylic resin properties [8-9]. Zinc oxide is a white-colored powder with a formula of ZnO, which can insoluble in water. Naturally it is found as the mineral zincite and can be produced synthetically [10]. The zinc is a white-blue colored metal found in pure form as brittle metal. The zinc, when heated, oxidizes results in a low density metal oxide [11-12]. In dentistry, Zinc oxide has used in wide applications in dentistry such as gutta-percha and root canal sealer [13-14]. The present study was to investigate the effect of ZnO filler on some physical properties of acrylic denture

base.

Materials

In this study, zinc oxide (Golchadent, Iran) was used to assess the physical properties of heat cured acrylic resin (Spofadental, Czech Republic) and dental stone (Zhermack, Italy). A total of 40 specimens were fabricated in the current study. They were divided into two groups with each group consists of 20 specimens. The first group was considered as control and the other group contained zinc oxide at 1% by weight. Such groups were subdivided into 2 groups for porosity and water sorption tests. For porosity test, a wax pattern with dimension of 30mm diameter and 2 mm thickness was used to fabricate acrylic specimens [15-17]. Initially, the upper and lower parts of a metal flask are separated using vaseline. The dental stone was mixed with water according to manufacturer instructions (40g/100ml) at creamy mix and poured into lower half of the flask. Then, the wax pattern was placed gently into middle of flask with taking into consideration half of pattern must be exposed as shown in the figure 1.

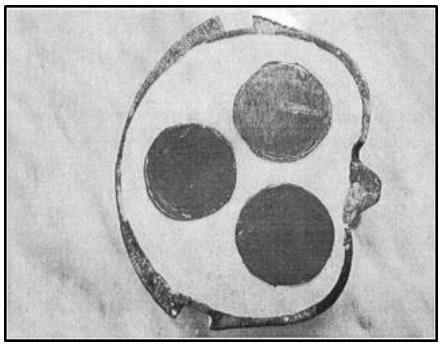

Figure 1.
Specimen for porosity test

The flask was left to set for one hour. The surface of dental stone was lubricated with the separating medium and left to dry for 15 min. The second layer was applied and the upper part of the flask was placed into position. Once drying, the wax pattern was fully invested and left to set for one hour. The mould was then placed into a boiling out machine for five minutes and then removed and opened. The upper and lower part of the mould was cleaned using detergent. The upper and lower parts of the mould are separated using separating medium. Heat cure clear acrylic resin polymer and monomer with a ratio of 3:1 was mixed. When the mixture reached dough, it was then packed into the mould and cured in water bath. After curing, the flask was removed from water bath and left to cool. The samples were removed from the flask, finished and polished. The specimens were kept in distilled water for 2

days before testing [18]. For zinc oxide groups, ZnO powder at 1% was added to dry acrylic powder, and the polymer and monomer with a ratio of 3:1 were mixed. When the mixture reached dough, it was then packed into the mould and cured in water bath. Once curing, the specimens were removed, finished and polished. All acrylic specimens were dried in desiccators containing freshly dried silica, which placed in an Incubator at 37°C±2°C for 24 hours. Following that, the specimens were weighed every 24 hours by analytical balance of accuracy 0.0001 g. This represents the weight of dried specimen (WD). The specimens were then immersed in distilled water for 24 hours at 37°C±2°C. Following that, each specimen was removed from water, dried and waved in air for 15 second and weighed. This represents the weight of specimen in water (Ws), the specimens were then weighed in a basket hangs plump in water, this will represent the weight of specimen inside the basket (Wn). The value of porosity calculated for each disc, from equation: (Ws-Wd)/(Ws-Wn)*100%. For water sorption, the above methodology was carried out t o fabricate acrylic specimens; a wax pattern with dimension of 30mm diameter and 2 mm thickness was used and conducted according to requirements of ISO 1567, 2005 [19].

Figure 2.

Specimen for water sorption

The following formula was utilised to obtain the water sorption' values.

Water sorption: (Ws-Wd)/Wd* 100%

Where Ws: represent weight of saturated sample in water

Wd: weight of dried sample.

Results

The effects of incorporation the zinc oxide powder at 1% into heat cured acrylic denture base were evaluated in terms of water sorption and porosity. All values of mean, standard deviation are presented in

Table 1. The current study showed that there was a slight decline in the values of mean in both porosity and water sorption after reinforcing the acrylic specimens with the zinc oxide filler compared to control group as illustrated in the figure 3. For instance, a low mean of porosity and water sorption was for micro filter (4.38 for porosity, 2.56 for water sorption) respectively, in comparison to unmodified group (4.63 for porosity, 2.98 for water sorption).

Table 1.

Mean & standard deviation of the studied groups.

	Water sorption	Water sorption	Porosity	Porosity
	Experimental	Control	Experimental	Control
Number	10	10	10	10
Mean	2.56	2.98	4.38	4.63
Std. Deviation	.564	1.859	.644	1.049
Minimum	1.50	1.12	3.50	3.70
Maximum	3.10	6.95	5.80	7.40

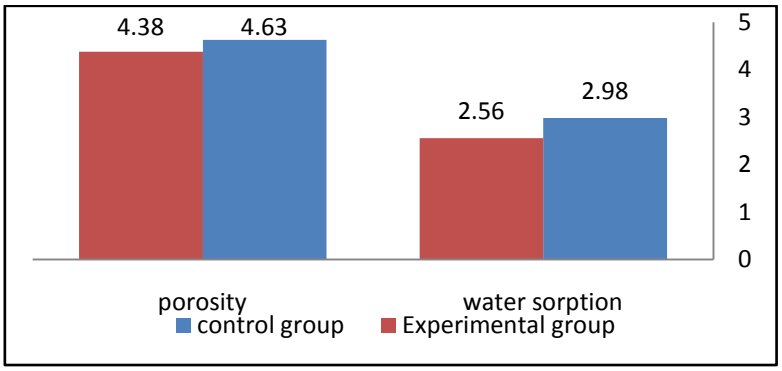

Figure 3.

Bar represents mean values for density with and water sorption

In addition, the present results showed that no significant differences between the two groups for both density and water sorption were observed where P>0.05.

Table 2.

Independent T test

Tests	Groups	T-test	P-Value	C.S
Water sorption	Control experimental	0.716	.492	(NS)* P>0.05
Porosity	Control experimental	0.580	.576	(NS)* P>0.05

NS*: Non significant: P>0.05

Discussion

In dentistry, the zinc oxide powder is extensively utilized for several purposes such as temporary filling, cement base, root canal filling and impression material. This additive is a radio-opaque material and in the current study is used to investigate the acrylic denture base in terms of porosity and water sorption. The amount of water absorption on the surface and to the body of the material is known as sorption which can be increased by its polarity. Diffusion is defined as the migration of one material to the space in a second material. This definition clarifies the water entry inside the acrylic surface occupying the position between polymer chains [20-21].The results of the present study revealed that a slight decrease in the water sorption after addition of ZnO particles. These results agree with the other study which found that the use of zro2 decreased the acrylic water sorption [22]. As well, our findings contrast Laura and associates [23] which concluded that the use TiO2 and Fe_2O_3 nano-particles presented a lower value of water sorption compared with unmodified acrylic specimens. In term of porosity, which are a complex phenomenon and it found on acrylic denture base depending on many factors such as polymerization method, the material and flaking technique used. It can be defined as the presence of voids or pores on the surface (i.e. acrylic). It is problematic to decide the cause of porosity whether from polymerisation or the material utilized [24]. In the current study, the study exhibited that there was a slight reduction in the porosity of acrylic resin after addition of ZnO nano-filler. The presence of such fillers within acrylic resin

results in increasing its density. It was found that there was adverse relationship between the density and porosity where increase in the density results in decrease in porosity and vise verse [25]. Regarding the type of filler used, the present results were in accordance with a study which was carried out by Lawra [23] who found the incorporation of both TiO2 and FeO2decreased the acrylic resin' porosity. Further study will be necessary to investigate the addition of ZnO filler in different concentration on acrylic denture physical properties.

Conclusion

The present study has concluded the following points:-

1. The incorporation of zinc oxide powder into acrylic denture base reduces its ' porosity.
2. In term of water sorption, there was a slight reduction following adding zinc oxide filler.

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Abbreviations

Where Ws: represent weight of saturated sample in water

Wd: weight of dried sample.

Wn: weight of specimen inside the basket

G= gram

ML= Milliliter

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