https://doi.org/10.25130/tjds.10.2.17

Tikrit Journal for Dental Sciences 10(2) (2022) 230-233

IRAQI Academic Scientific Journals

ISSN:2073-1213

Tikrit Journal

for

Dental Sciences

https://tjds.tu.edu.iq

The Influence of Incorporating Zno on The Surface Hardness of Poly Methyl Methacrylate. In Vitro Study

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Article Info:
-Article History:
-Received: 15/2/2022
-Accepted: 30/3/2022
-Available Online:
Dec, 2022

Keywords:
Zinc oxide, Acrylic resin, Surface hardness.

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Abstract

Introduction: Heat cured resins are commonly utilized for construction of complete and partial dentures. Such materials have poor mechanical properties and may be exposed to fracture. The present study, therefore, was conducted to evaluate the impact of incorporating ZnO on acrylic resins' surface hardness. Materials and Methods: Twenty specimens were constructed in total. The study composed of 2 major sets, and each set had ten specimens. The 1st set had 1% zinc oxide and the second group had no zinc oxide and considered as control. All samples were subjected to the hardness test three times and average reading was recorded for all specimens. Results: a significant decrease in the surface hardness of acrylic resins following the incorporation of ZnO (control group: 127.62+2.53 g/mm^2, zinc oxide group: 106.67+ 1.51). Conclusions: The addition of zinc oxide at 1 % would decrease the surface hardness of acrylic resins.

Introduction

Heat cured resins are the most common materials used in removable prosthodontics (1, 2) . These materials are easy to be manipulated by the dental technician. Though, these substances have poor mechanical properties and may be exposed to fracture (3- 5) . The ZnO powder is found as the mineral zincite and used widely in dental applications such as root canal sealer(6). According to the literature, many investigations have been conducted to assess the physical and mechanical characteristics of acrylic resins via some reinforcements such as titanium dioxide and silver nitrate. The literature indicated that the incorporation of such particles enhanced the acrylic resins 'surface properties (7-12). The current study aimed to assess the influence of ZnO on surface hardness of acrylic resins.

Materials And Methods

In current study, twenty specimens of heat cured resins (Spofadental, the Czech Republic) were fabricated in total. They were 2 sets; and each set had ten specimens. The control group was made without the addition of ZnO while the experimental group (zinc oxide) was made from heat cured acrylic resin with adding 1% zinc oxide (Golchadent, Iran). Plastic strips (65 mm, 10 mm, 2.5 mm) were utilized to fabricate acrylic specimens (13). The procedure of making the acrylic specimens involved lubricating the 2 halves of a metal flask with tinfoil separating medium. Following that, dental stone and water were hand-mixed according to instructions given by manufacturers. The mixed stone was then poured into the lower part of the metal flask. Then, plastic strips were located gently in the middle taking into account 1mm of their thickness should be visible to be simply removed (Fig. 1). The tinfoil separating medium was then applied after the complete set of the stone surface, and then the upper part was put into its position. Another mix stone was poured over the stone surface and strips and left for 60 minutes. After that, the upper and lower parts were separated; and strips taken away, and the separating medium was applied to the stone mould and left to dry (Fig. 2). The control group was made from 22 grams of acrylic powder and 10 milliliters of monomer liquid. When the acrylic reached a dough stage, it was placed within the mould and then the flask was compressed underneath the hydraulic press, and then cured according to manufacturer instructions. Afterward, the flask was taken away from the water bath machine. Once cooling, acrylic specimens were then extracted from stone mould and finished and polished via traditional method. On the other hand, the experimental group was fabricated from acrylic powder(21.78 grams), zinc oxide (0.22grams) and monomer liquid (10 milliliters). Then acrylic specimens were preserved in water for 2 days before undertaking the surface hardness test.

Hardness test

A Vickers microhardness tester (Matsuzawa, Japan) was used to test acrylic samples. The sample surface was subjected to a load of 50 g for ten seconds three times (right, middle, left) and then for each sample, average reading was recorded (Fig. 3).

Results

The table 1 indicated a significant reduction in the means of acrylic resins' surface hardness. Moreover, significant differences (*P*-value < 0.001) were observed between 2 groups as demonstrated in Table 2.

Discussion

Heat cured resins are extensively utilized in many applications in removable prosthodontics because of their appropriate characteristics. However, these substances have poor strength. The goal of the present research was to assess the addition of zinc oxide on the hardness of resins. In the current study, there were 2 groups, control and zinc oxide. The results indicated a significant decline in the surface hardness after adding 1 % zinc oxide. The present findings are in disagreement with Al-Shammari (10) which indicated that ZnO increases slightly acrylic resins' surface hardness due to the good bond between polymer chains which produced from zinc oxide nanoparticles. However, the present findings agreed with Andreotti (12) which showed the zinc oxide act as plasticizers and residual monomers in acrylic resin which would decrease significantly the surface hardness of acrylic resin ocular prosthesis.

Conclusion

The research was an effort to explore the impact of incorporating ZnO on acrylic resins' surface hardness. The study concluded that zinc oxide significantly reduces the surface hardness of acrylic resins. Further investigation is recommended to evaluate the impact of ZnO on other physical and mechanical properties of resins.

List of abbreviations
g = gram
ml = milliliter
mm= millimeter

Acknowledgements
Special thanks to Mr.khalid, the head of Materials Laboratory , Technology University.

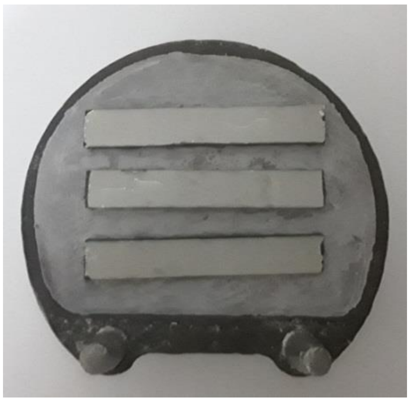

Fig. (1): Dental stone mold and plastic patterns

Fig.(2): The dental stone mould

Fig. (3): Specimen under testing

Table (1): Means and standard deviation for all groups

Group	Number	Mean	Standard deviation
Control	10	127.62	2.53
Zinc oxide	10	106.67	1.51

Table (2): Comparison between groups

Groups	P value	Sig
Control - ZnO	.000	High significant *P*-value < 0.001

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