J Oral Res
research in oral sciences

Article

Effects of chemical disinfectants on surface hardness of heat -cured acrylic resins. *In vitro* study

Efectos de los desinfectantes químicos sobre la dureza superficial de las resinas acrílicas termocuradas. Estudio *in vitro*.

Firas Abd Kati.[1]

Affiliations:

[1]Department of Dental Technology, College of Health & Medical Technology, Middle Technical University, Baghdad, Iraq.

Corresponding author: Firas Abd Kati. College of Health & Medical Technology, Middle Technical University, Baghdad, Iraq. Phone: (077) 18562575.
E-mail: **firas_abd26@mtu.edu.iq**

Receipt : 05/03/2021 Revised: 06/25/2021
Acceptance : 10/31/2021

Abstract: Introduction: Acrylic resins (*i.e.*, heat cured acrylic resins) are the most common materials used to manufacture removable dental prostheses involving maxillofacial prostheses such as obturators. Their mechanical and physical properties must be adequate for their use and durability. It is therefore vital to assess how their properties are affected by different disinfectants. Aims: The purpose of this research was to evaluate the effect of chemical disinfectants on surface hardness of the acrylic resins. Material and Methods: Forty specimens (65 mm in length, 10 mm in width and 2.5 mm thick) were manufactured from heat cured acrylic resins for hardness testing according to ISO 1567:1999. The study consisted of four main sets according to the disinfectants applied (control, 1% hypochlorite, 4 % chlorhexidine, and Efferdent®) and each set contained ten specimens. All specimens were placed in saline solution at 37°C and incubated for 60 days. Acrylic specimens were then tested by using a hardness tester three times and the average reading was recorded. All data were analyzed using SPSS version 16. The results were analyzed at a significant level ($p \leq 0.05$). The ANOVA (analysis of variance) test was used to assess whether there were any significant differences among all groups. The comparisons between means were obtained by using a Tukey test. Results: There was a slight decrease in the mean values of surface hardness after immersing in chemical disinfectants. The chlorhexidine-assigned specimens had the lowest value of mean surface hardness. On the other hand, the control group had the highest mean value. However, there were no significant differences regarding surface hardness among all groups ($p > 0.05$). Conclusion: The use of chemical disinfectants slightly decreases the surface hardness of heat-cured acrylic resins.

Keywords: *hardness tests; acrylic resins; maxillofacial prosthesis; disinfectants; sodium hypochlorite; chlorhexidine.*

Resumen: Introducción: Las resinas acrílicas (es decir, las resinas acrílicas termocuradas) son los materiales más comunes utilizados para fabricar prótesis dentales removibles que involucran prótesis maxilofaciales como los obturadores. Sus propiedades mecánicas y físicas deben ser adecuadas para su uso y durabilidad. Por lo tanto, es vital evaluar cómo sus propiedades se

Cite as: Kati FA. Effects of chemical disinfectants on surface hardness of heat -cured acrylic resins. *In vitro* study. J Oral Res 2021; 10(6):1-6. doi:10.17126/joralres.2021.074

ven afectadas por diferentes desinfectantes. **Objetivos:** El propósito de esta investigación fue evaluar el efecto de los desinfectantes químicos sobre la dureza superficial de las resinas acrílicas. **Material y Métodos:** Se fabricaron cuarenta especímenes (65 mm de largo, 10 mm de ancho y 2,5 mm de espesor) a partir de resinas acrílicas termocuradas para pruebas de dureza de acuerdo con la norma ISO 1567:1999. El estudio constaba de cuatro conjuntos principales según los desinfectantes aplicados (control, hipoclorito al 1 %, clorhexidina al 4 % y Efferdent®) y cada conjunto contiene diez muestras. Todos los especímenes se colocaron en solución salina a 37°C y se incubaron durante 60 días. A continuación, las muestras de acrílico se probaron tres veces con un probador de dureza y se registró la lectura promedio. Todos los datos se analizaron con SPSS versión 16. Los resultados se analizaron a nivel significativo ($p \leq 0,05$). Se utilizó la prueba ANOVA (análisis de varianza) para evaluar si había diferencias significativas entre todos los grupos. Las comparaciones entre medias se obtuvieron mediante la prueba de Tukey. **Resultados:** Hubo una ligera disminución en los valores medios de dureza superficial después de la inmersión en desinfectantes químicos. Los especímenes asignados con clorhexidina tenían el valor más bajo de dureza superficial media. Por otro lado, el grupo control presentó el valor medio más alto. Sin embargo, no hubo diferencias significativas en cuanto a la dureza superficial entre todos los grupos ($p>0,05$). **Conclusion:** El uso de desinfectantes químicos disminuye levemente la dureza superficial de las resinas acrílicas termopolimerizables.

Palabras Clave: *pruebas de dureza; resinas acrílicas; prótesis maxilofacial; desinfectantes; hipoclorito de sodio; clorhexidina*

INTRODUCTION.

In maxillofacial rehabilitation, obturator prosthesis is a prosthesis which closes the defect in the hard palate and or soft palate as a result of congenital and acquired malformations. heat cured acrylic resin materials are usually utilized for fabrication of complete and partial obturator prostheses.[1,2] Dental prostheses may be contaminated with viruses, fungi or bacteria when they are removed from the patient mouth during insertion and trial. The contaminated prostheses can spread a variety of microorganisms which lead to a variety of infectious diseases such as hepatitis B, herpes, tuberculosis among others.[3]

Hence, dental prostheses must be disinfected before being used by the patient.[4,5] The immersion of dental prostheses in chemical disinfectants aims to inactivate bacteria, viruses and fungi.[6]

The most common chemical disinfectants for dental prostheses are sodium hypochlorite, gluta-raldehyde and chlorine dioxide.[7] The immersion of removable dentures in disinfectants might decrease the amount of the microorganisms on the surface of dental prostheses.[8,9] Numerous studies demonstrated that various disinfectants influence the acrylic properties like hardness and transverse strength.[10,11]

The current study was conducted to evaluate the effect of chemical disinfectants on surface hardness of heat-polymerized acrylic resins. The null hypothesis was that there were no significant differences among all groups.

MATERIALS AND METHODS.

Materials

In total, 40 specimens of heat cured acrylic resins (Spofadental, Jicin, Czech Republic) were divided into four groups according to different disinfectants used, each group containing ten specimens.

The first group was the control group (without disinfectant);

The second group was disinfected in 1% hypochlorite (Manipulation Pharmacy, São Paulo, Brazil);

The third group was disinfected in 4% Chlorhexidine (Manipulation Pharmacy, São Paulo, Brazil);

and the fourth group was disinfected in Efferdent® (Pfizer Consumer Health, Morris Plains, NJ, USA).

Specimens' preparation

In this study, a metal strip (65 mm length, 10 mm width and 2.5 mm thickness) was used to make the acrylic specimens hardness testing, according to ISO 1567:1999.[12] The process of fabricating the specimens

started by coating the two parts of a metal flask with Vaseline® in order to remove the acrylic specimens from the stone mold after deflasking.

Dental stone type 3 (Zhermack, Badia Polesine, Rovigo, Italy) and water were hand-mixed according to manufacturer instructions. The mix was poured at the creamy state into the lower part of the flask and the metal strip was then positioned in the center. The separating medium (Zinnfoile, Dentaurum Pforzheim, Germany) was applied following the complete set of the stone surface.

The upper part was then located into its correct site. A second mix of dental stone and water was prepared and poured above the metal strip and stone surface. The flask was allowed to set for one hour. The two halves of the flask were then separated, the strip carefully removed and the mold was cleaned with detergents and left to dry.

The two parts of the stone mold were coated with tin foil separating the medium. Once dry, the acrylic powder and monomer liquid were mixed in a small container according to the manufacturer instructions (22g / 10 ml). The acrylic dough was placed inside the stone mold; the flask was put under the hydraulic press; and then cured in a water bath machine following the instructions supplied by the manufacturers.

Once cured, the flask was removed from the water bath and left to cool. Acrylic specimens were then removed from the stone mold and finished with stone and acrylic burs.

All specimens were polished in a dental lathe using a pumice and rouge.

All specimens were then placed in saline solution at 37°C for 50 ± 2 h to hydrate them while residual monomers were eliminated.[13] Acrylic specimens were disinfected for 60 days. Specifically, hypochlorite and chlorhexidine assigned specimens were disinfected daily via manual friction and gauze for one minute and then rinsed in running water for 30 seconds.[14]

Efferdent® assigned specimens were disinfected three times a week and were immersed in a solution of distilled water with an effervescing tablet at 37°C for 15 minutes, and rinsed in running water for 30 seconds.[15]

Hardness test

A hardness tester (Shore D, Italy) was utilized for testing the acrylic specimens. Each specimen was subjected to a load (50g) for 10 seconds 3 times (middle, left, right). The average reading was then recorded.

RESULTS.

The SPSS v.16 software was used for statistical analysis of the data. The results indicated that the mean values of the surface hardness of acrylic specimens decreased slightly after immersing in chemical disinfectants, with similar standard deviations Control group: 127.6+2.52;

Hypochlorite group: 126.3+2.53;

Chlorhexidine group: 126.1+2.59;

Efferdent group: 126.8 +2.54, (Table 1). Moreover, no significant differences (p>0.05) were found between all studied groups, (Table 2 and Table 3).

Table 1. Mean and standard deviation values for all groups.

Groups	n	Mean	Standard deviation
Control (without disinfection)	10	127.6	2.52
1% Hypochlorite	10	126.3	2.53
4% Chlorhexidine	10	126.1	2.59
Efferdent®	10	126.8	2.54

ISSN Print 0719-2460 - ISSN Online 0719-2479.

Table 2. Comparison between groups.

Groups	*p*-value
Control - Efferdent	.885*
Control- Hypochlorite	.676*
Control- Chlorhexidine	.562*
Efferdent- Hypochlorite	.978*
Efferdent-Chlorhexidine	.937*
Hypochlorite- Chlorhexidine	.998*

*: Non-significant ($p>0.05$)

Table 3. Results from the ANOVA test.

Hardness	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.144	3	4.381	.674	.573
Within Groups	233.918	36	6.498		
Total	247.062	39			

DISCUSSION.

At the clinic, dental prostheses may be contaminated by microorganisms which could be transmitted from patients to dental staff during dental treatment.

Hence, an infection control process is suggested for avoiding cross-contamination and infections. The use of chemical disinfectants might affect the acrylic resin surface properties. The study aimed to assess the influence of different disinfectants on acrylic resins in terms of surface hardness. In the present study, there were four groups according to the disinfectants used (control, Efferdent®, chlorhexidine and sodium hypochlorite).

Chemical disinfectants such as 4% chlorhexidine and 1% sodium hypochlorite have demonstrated to be more effective in decreasing the number of microorganisms on dental prostheses.[9] In addition, effervescent tablets are preferred for dental prostheses as they promote the release of oxygen and eliminate stains and debris from the material.[16]

The present findings showed a slight decrease in the mean values of surface hardness of acrylic resins after immersing in chemical disinfectants.

However the current results indicate that there are no significant differences in surface hardness between the groups ($p>0.05$).

These results were supported by a study which was carried out by Carvalho *et al.*,[10] who found that the use of both chlorhexidine and 1% sodium hypochlorite reduced only slightly the surface hardness of the acrylic resins.

Furthermore, the present results agreed with Moreno *et al.*,[17] who reported that the use of chemical disinfectants decreased slightly the surface hardness of the acrylic resins utilized for ocular prostheses. They also found that the repeated manual friction and disinfected method could remove particles from the acrylic surface. Also, chemical disinfectants act as plasticizers on the polymer matrix that would decrease the surface hardness of acrylic resins.

CONCLUSION.

This study was carried out to assess the influence of using different disinfectants on surface hardness of heat cured acrylic resins.

The use of chemical disinfectants (hypochlorite, chlorhexidine, and Efferdent®) decreased slightly the surface hardness of acrylic resins.

Evaluation of the effects of different disinfectants on other properties of heat cured acrylic resins are required.

Conflict of interests: None declared.
Ethics approval: Does not apply.
Funding: Self-funded.
Authors' contributions: I have worked on the realization and correction of this manuscript
Acknowledgements: None.

ISSN Print 0719-2460 - **ISSN Online** 0719-2479.

REFERENCES.

1. Beumer J, Marunick M, Esposito S. Maxillofacial rehabilitation: prosthodontic and surgical management of cancer -related , acquired and congenital defects of the head and neck. THIRD EDITION ,2011.
2. Singh M, Bhushan A, Kumar N, Chand S. Obturator prosthesis for hemimaxillectomy patients. National journal of maxillofacial surgery. 2013; 4(1), 117–120. https://doi.org/10.4103/0975-5950.117814
3. Orsi IA, Andrade VG. Effect of chemical disinfectants on the transverse strength of heat-polymerized acrylic resins submitted to mechanical and chemical polishing. J Prosthet Dent 2004; 92:382-388.
4. ADA Council on Scientific Affairs and ADA Council on Dental Practice: Infection control recommendations for the dental office and the dental laboratory. ADA Council on Scientific Affairs and ADA Council on Dental Practice. J Am Dent Assoc. 1996 May;127(5):672-80. doi: 10.14219/jada.archive.1996.0280. PMID: 8642147.
5. Polyzois GL, Zissis AJ, Yannikakis SA. The effect of glutaraldehyde and microwave disinfection on some properties of acrylic denture resin. Int J Prosthodont 1995; 8:150-154.
6. Sangwai P, Thombare R, Godbole S, Pakhan A. "Effect of Two Chemical Disinfectants and Time of Immersion on the Transverse Strength of Three Heat Polymerizing Acrylic Resins Subjected to Short Curing Cycle- An in Vitro Study." Sch J Dent Sci. 2016; 3(9):251-6
7. Campanha NH, Pavarina AC, Vergani CE, Machado AL. Effect of microwave sterilization and water storage on the Vickers hardness of acrylic resin denture teeth. J Prosthet Dent. 2005 May;93(5):483-7. doi: 10.1016/j.prosdent.2005.02.016. PMID: 15867760.
8. Pavarina AC, Machado AL, Giampaolo ET, Vergani CE. Effects of chemical disinfectants on the transverse strength of denture base acrylic resins. J Oral Rehabil. 2003 Nov;30(11):1085-9. doi: 10.1046/j.1365-2842.2003.01150.x. PMID: 14641673.
9. Pavarina AC, Vergani CE, Machado AL, Giampaolo ET, Teraoka MT. The effect of disinfectant solutions on the hardness of acrylic resin denture teeth. J Oral Rehabil. 2003; 30(7):749-52. doi:10.1046/j.1365-2842.2003.01145.x. PMID: 12791163.
10. Carvalho CF, Vanderlei AD, Marocho SM, Pereira SM, Nogueira L, Paes-Júnior TJ. Effect of disinfectant solutions on a denture base acrylic resin. Acta Odontol Latinoam. 2012;25(3):255-60.
11. Savabi O, Attar K, Nejatidanesh F, Goroohi H, Badrian H. Effect of different chemical disinfectants on the flexural strength of heat-polymerized acrylic resins. Eur J Prosthodont Restor Dent. 2013 Sep;21(3):105-8.
12. International Organization for Standardization. ISO 1567:1999 Dentistry — Denture base polymers. ISO/TC 106/SC 2 Prosthodontic materials. 1999; 3:27.
13. Fernandes AU, Portugal A, Veloso LR, Goiato MC, dos Santos DM. Assessment of the flexural strength of two heat-curing acrylic resins for artificial eyes. Braz Oral Res. 2009; 23: 263–7.
14. Goiato MC, dos Santos DM, Gennari-Filho H, Zavanelli AC, Dekon SF, Mancuso DN. Influence of investment, disinfection, and storage on the microhardness of ocular resins. J Prosthodont. 2009; 18: 32–35.
15. Goiato MC, Haddad MF, dos Santos DM, Pesqueira AA; Moreno A. Hardness evaluation of prosthetic silicones containing opacifiers following chemical disinfection and accelerated aging. Braz Oral Res. 2010; 10(3): 303-8.
16. Goiato MC, Zucolotti BC, Mancuso DN, dos Santos DM, Pellizzer, EP, Ramos VF. Care and cleaning of maxillofacial prostheses. J Craniofac Surg. 2010; 21: 1270-3.
17. Moreno A, Goiato M, Santos D, Haddad M, Pesqueira A, Bannwat L. Effect of different disinfectants on the microhardness and roughness of acrylic resins for ocular prosthesis. Gerodontology. 2013; 30(1): 32-9.