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Research Article

Flexure Strength and Hardness Number of Conventional Denture Base Material after 2.4% Glutaraldehyde Disinfection

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Abstract

This study reassesses the effect of glutaraldehyde disinfection on the flexure strength and hardness of commercial acrylic resin denture base material. Thirty specimens from a commercial heat cured denture base material were prepared according to the ADA specification No. 12 for denture base resins. Specimens for each test were divided into two groups. The first group was stored in distilled water for 48 hours (control) and the other one was soaked in glutaraldehyde for ten hours. I concluded that immersion of Stellon QC-20 for ten hours in 2.4% glutaraldehyde did not significantly affect its flexure strength, while reducing its hardness.

Keywords: *Acrylic Resin; Flexure Strength; Vickers Hardness; Glutaraldehyde*

Introduction

Since early synthesized by Walter Bauer in 1936, acrylic resin became most commonly used denture base material than traditional metal base materials in clinical setting [1,2]. Although there have been dramatic developments in removable prosthodontics in recent years, the use of complete and removable partial acrylic resin dentures continues to be of significant value, particularly in the elderly population [3]. Acrylic resin prosthesis has been identified as a source of cross contamination between patient and dental personnel [4]. Because illness in elderly is complicated by physical changes of aging and by multiple medical problems, it is essential for dentists; dental laboratory technicians to proper sterilize and disinfect all prostheses and dental appliances in both dental office and laboratory before being intraoral inserted as a standard precaution.

It is well known that chemical disinfectants are the recommended method to sterilize acrylic resin base materials. The commonly used chemical agents for disinfection of acrylic resin prostheses are chlorine compounds [5]. However, their sporicidal efficiency is more often presumed than proven. Furthermore, the sporicidal effect of 2% glutaraldehyde for ten hours is well documented [6,7].

An increased frequency of resin failure can be demonstrated by flexural strength testing, likewise, reduction in the hardness might adversely affect the function and the aesthetics of resin prostheses [8]. Although, several studies have attempted to determine whether disinfection of acrylic resin with common chemical methods can affect its flexure strength and hardness, no much effort have been devoted concerning the effect of 2.4% glutaraldehyde on the flexure strength and hardness of acrylic resin [9-18].

Considering these facts, the present study is undertaken to evaluate the effect of 2.4% glutaraldehyde sterilization on the flexure strength and the hardness of a commercially used heat cured polymethyl methacrylate.

Methods

A total of sixty samples were divided into two groups. The first group (FS) was used to test flexure strength and the second one (H) was used to test hardness. Each group was subdivided into two subgroups. The first two subgroups (FS-1, H-1) were used as a control, soaked in distilled water for forty-eight hours at room temperature (RT) , while the other two subgroups (FS-2, H-2) were tested after soaking in glutaraldehyde (CIDEX, Johnson& Johnson, UK) for ten hours and distilled water for thirty-eight hours at RT (Table 1).

Material	Control Group	Experimental Group
Flexure Strength (FS)	FS1	FS2
Hardness (H)	H1	H2

Table 1: *Test and Control Groups.*

In order to prepare standardized samples for flexure strength and hardness tests a specially designed copper mold was fabricated (Figure 1A). The special mold contained five rectangular beds, each with inner dimensions of, 65 mm length, 10 mm width, and 2.5 mm thickness, (Figure 1B) as was recommended by the ADA specification No. 12 for denture base polymers [19]. The copper mold was designed to be placed in a specially designed copper flask used for curing the samples (Figure 1C).

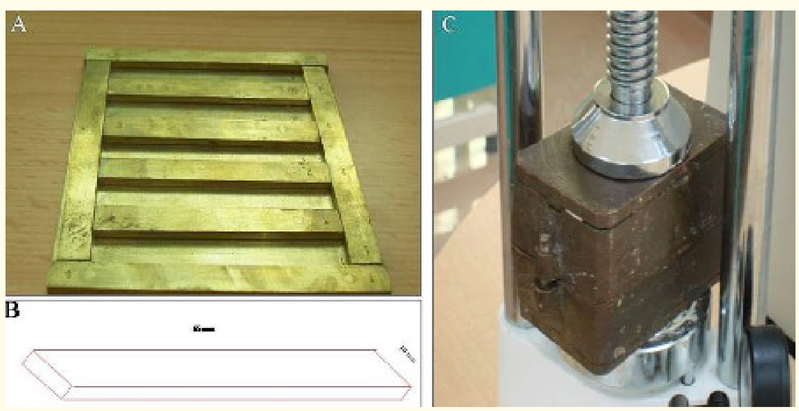

Figure 1: *Hany M Khattab.*
(A) The copper split mold
(B) Diagram of specimen's dimensions (65 mm length, 10 mm width, and 2.5 mm thickness)
(C) The copper flask.

The studied heat-cured resin Stellon QC-20 (DENTSPLY limited, DENTSPLY, UK) was selected as representative of the conventional polymethyl methacrylate heat-polymerizing acrylic resins that are commonly used for denture resin fabrication.

Measurements of Flexure Strength and Hardness

A universal testing machine (Instron 5500R, Instron, USA) was used to determine the transverse strength by a three point loading test (Figure 2A, 2B). A Vickers micro hardness tester (Vickers micro hardness tester, Shimadzu micro hardness, Tokyo, Japan) was used to measure the hardness of the prepared specimens under a load of 245.2 mN. The indenter was pressed into the samples by an accurately controlled test force [20-21].

Data were analyzed by Student's t-test and values of p equaling 0.05 or less considered to be significant.

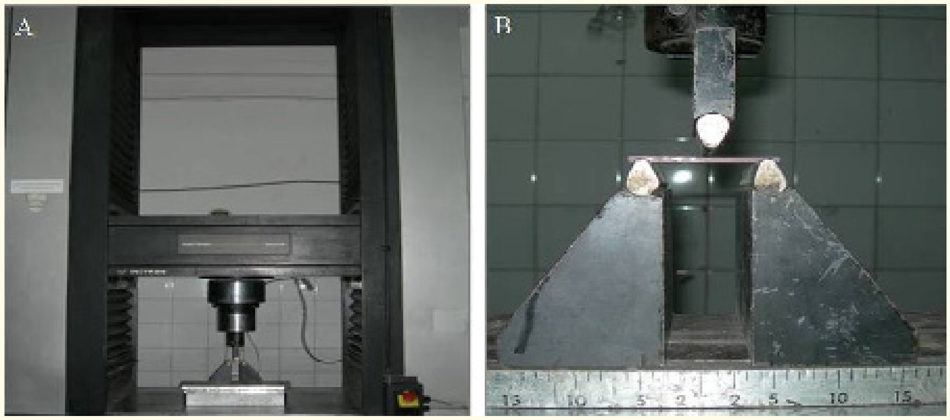

Figure 2: *(A) Universal testing Instron machine*
(B) Three point loading test.

Results

The results of the flexure strength testing are shown in Table 2. Group FS-1 presented mean shear bond strength value of 81.33 N/mm^2, whereas group FS-2 presented mean value of 80.9 N/mm^2. Results showed no significant difference between the mean bending strength of both groups (*p*-value: 0.940). As can be seen in Table. 3, group H-1 promoted higher mean hardness number values of 19.04, compared with 17.39 in H-2 group. Differences were statistically different when specimens were immersed in glutaraldehyde (*p*-value: 0.001).

Group FS1		Group FS2		*n*	*p* - value
Mean	SD	Mean	SD		
81.33	14.52	80.9	16.23	15	0.940

Table 2: *The effect of glutaraldehyde on the flexure strength of the tested resin.*

Group H1		Group H2		*n*	*p* - value
Mean	SD	Mean	SD		
19.04	0.93	17.39	0.52	15	0.001**

Table 3: *The effect of glutaraldehyde on the Vickers hardness number of the tested resin.*

Discussion

This study was undertaken to evaluate the alteration in the flexure strength and hardness of a commercial heat-polymerized denture base acrylic resin material after soaking in glutaraldehyde. The results showed that the flexure strength of the tested heat cured resin denture base material was not significantly affected after being soaked in glutaraldehyde for 10 hours, while a significant difference between the hardness of both groups was inspected.

Our findings was in accordance with Polyozois., *et al*. [20,22], who observed, no change in the flexure strength of the resin after immersion in 2% glutaraldehyde for one hour. The data presented in Table 3 showed, that there was a significant difference in the hardness of group H-1 and H-2. This was in agreement with Polyozois., *et al*. [20] who observed, that the immersion of an acrylic denture base in

2% glutaraldehyde for even one hour resulted in a decrease in its micro hardness [20], however contradicted the work of Dr. Asad and his colleages [23]. A possible explanation for the decrease in hardness might be the disinfectant plasticizing effect. Upon immersion of the acrylic samples in glutaraldehyde, the latter was sorbed and slowly dissolved the surface leading to softening and possible change in the surface characteristics of the polymer. This assumption was supported by Nolte [24], who stated, that the low surface tension of glutaraldehyde permitted easy penetration of the solution into the exposed surface. The easy diffusion of the solution into the polymer progressively relaxed the polymer chains and subsequently lowered the hardness of the acrylic resin denture base material.

Conclusions

The results of this study showed that surface mechanical property like hardness is affected by the glutardehyde sterilization, but principle mechanical property like flexture strength was not affected after immersion of Stellon QC-20 for ten hours in 2.4% glutaraldehyde solution. Within the limits of this study, further efforts are required in the development of sterilization protocols for acrylic resin denture base materials in prosthodontics to advance long-term care for elderly patients. Yet, it is essential notifying the reported adverse health effects of glutaraldehyde, accordingly this method is not a familiar process that can be used by denture wearers, nevertheless are restricted to be used in dental clinics by recognized control methods to prevent or diminish exposure hazards. New methods for denture disinfections, for instance the use of reactive oxygen species (ROS) are recommended for further improvement of dentures disinfection strategies, however the sporicidal effect of this disinfectant together with its adverse effect on the mechanical properties of acrylic resin denture base material are still questionable [25-26].

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Ethical Approval

No ethical approval is necessary for this study.

Conflict of Interest

The author reported no conflict of interest related to this study.

Bibliography

1. Sharan S., *et al*. "Effect of chemical disinfectant on the transverse strength of heat-polymerized acrylic resins subjected to mechanical and chemical polishing: an *in vitro* study". *The Journal of Contemporary Dental Practice* 13.3 (2012): 389-393.
2. Yingying P., *et al*. "Novel acrylic resin denture base with enhanced mechanical properties by the incorporation of PMMA-modified hydroxyapatite". *Progress in Natural Science: Materials International* 23.1 (2013): 89-93.
3. Jones JD., *et al*. "Removable partial dentures–treatment now and for the future". *Texas Dental Journal* 127.4 (2010): 365-372.
4. Lin JJ., *et al*. "Disinfection of denture base acrylic resin". *The Journal of Prosthetic Dentistry* 81.2 (1999): 202-206.
5. Asad T., *et al*. "The effect of disinfection procedures on flexural properties of denture base acrylic resins". *The Journal of Prosthetic Dentistry* 68.1 (1992): 191-195.
6. Power EG and Ruseel AD. "Sporicidal action of alkaline glutaraldehyde: factors influencing activity and comparison of other Aldehydes". *The Journal of Applied Bacteriology* 69.2 (1990): 261-268.
7. Babb JR., *et al*. "Sporicidal activity of glutaraldehyde and hypochlorites and other factors influencing their selection for the treatment of medical equipment". *The Journal of Hospital Infection* 1.1 (1980): 63-75.

8. Schwindling FS., *et al*. "Effect of chemical disinfection on the surface roughness of hard dentures base materials: a systemic literature review". *The International Journal of Prosthodontics* 27.3 (2014): 215-225.
9. Goiato MC., *et al*. "Effect of thermal cycling and disinfection on micro hardness of acrylic resin denture base". *Journal of Medical Engineering & Technology* 37.3 (2013): 203-207.
10. Moreno A., *et al*. "Effect of different disinfectants on the micro hardness and roughness of acrylic resins for ocular prosthesis". *Gerodontology* 30.1 (2013): 32-39.
11. Campanha NH., *et al*. "The effect of long-term disinfection procedures on hardness property of resin denture teeth". *Gerodontology* 29.2 (2012): 571-576.
12. Goiato MC., *et al*. "Effect of disinfection and storage on the flexural strength of ocular prosthetic acrylic resins". *Gerodontology* 29.2 (2012): e838-e844.
13. Carvalho CF., *et al*. "Effect of disinfectant solutions on a denture base acrylic resin". *Acta Odontologica Latinoamericana* 25.3 (2012): 255-260.
14. Silva PM., *et al*. "Effect of repeated immersion solution cycles on the color stability of denture tooth acrylic resins". *Journal of Applied Oral Science* 19.6 (2011): 623-627.
15. Goiato MC., *et al*. "Influence of investment, disinfection, and storage on the micro hardness of ocular resins". *Journal of Prosthodontics* 18.1 (2009): 32-35.
16. Azevedo A., *et al*. "Effect of disinfectants on the hardness and roughness of reline acrylic resins". *Journal of Prosthodontics* 15.4 (2006): 235-242.
17. Campanha NH., *et al*. "Effect of microwave sterilization and water storage on the Vickers hardness of acrylic resin denture teeth". *The Journal of Prosthetic Dentistry* 93.5 (2005): 483-487.
18. Machado AL., *et al*. "Effect of microwave disinfection on the hardness and adhesion of two resilient liners". *The Journal of Prosthetic Dentistry* 94.2 (2005): 183-189.
19. ADA Council on Scientific Affairs and ADA Council on Dental Practice. "Infection control recommendations for the dental office and the dental laboratory". *Journal of the American Dental Association* 127.5 (1996): 672-680.
20. Polyzois GL., *et al*. "The effect of glutaraldehyde and microwave disinfection on some properties of acrylic denture resin". *The International Journal of Prosthodontics* 8.2 (1995): 150-154.
21. Khon DH. "Mechanical Properties. Textbook of Restorative Dental Materials". 11th ed, St. Louis, Mosby. 2002 pp. 68-121.
22. Robinson JG., *et al*. "Denture bases: the effects of various treatments on clarity, strength and structure". *Journal of Dentistry* 15.4 (1987): 159-165.
23. Shen C., *et al*. "The effect of glutaraldehyde base disinfectants on denture base resins". *The Journal of Prosthetic Dentistry* 61.5 (1989): 583-589.
24. Asad T., *et al*. "The effects of various disinfectant solutions on the surface hardness of an acrylic resin denture base material". *The International Journal of Prosthodontics* 6.1 (1993): 9-12.
25. Nolte WA. "Oral Microbiology". 3rd ed. St Louis, Mosby, 1977 pp. 55-87.
26. Odagiri K., *et al*. "Evaluation of denture base resin after disinfection method using reactive oxygen species (ROS)". *Dental Materials Journal* 31.3 (2012): 443-448.

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