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ORIGINAL STUDY

Evaluation of Heated Cure Acrylic Immersed in Ozonated Water

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Abstract

Background: **Denture cleansing is an important step that can prevent the spread of infection and improve a patient's health, the durability of the dentures, and the overall quality of life; therefore, it is necessary to choose a suitable cleanser that, in addition to being effective, does not have an unfavorable effect on the qualities of the denture base resin itself when used for an extended period.**

Aim: **This research aims to assess the effects of ozonated water on the surface roughness and hardness of heat-cured acrylic resin by immersion technique.**

Materials: **Sixty bars shape made of heat-cured acrylic were manufactured. Thirty samples for every test, including: (surface hardness and surface roughness). Then, these samples were divided into three groups, ten samples for each test group:**

- **The control group (immersion of samples in distal water).**
- **The group OZ-10 min (immersion in 2 mg/L ozone water disinfectant for 10 min).**
- **The group OZ-20 min (immersion in 2 mg/L ozone water disinfectant for 20 min).**

Next, the samples were tested using a profilometer tester and Vickers microhardness.

Result: **the hardness test readings were statistically significantly impacted by ozonized water but may be within clinically acceptable because the mean value was near. At the same time, the values of the mean roughness test did not significantly change ($P > 0.05$) after soaking samples in ozone water among the groups.**

Conclusion: **Ozonized water had no adverse effects on heat-cured acrylic resin regarding surface roughness, but it did cause a decrease in hardness that was statistically significant but within clinically acceptable at 2 mg/L concentration for (10 and 20) minutes.**

Keywords: Ozone water, Microhardness, Heat-cure acrylic, Surface roughness

1. Introduction

Dentures must be regularly cleaned to preserve oral mucosal health and the lifetime of partial removable dentures. Inadequate oral health may be the result of bacterial and fungal colonization of dentures, which can lead to denture stomatitis and angular cheilitis [1]. Airborne transmission of opportunistic microorganisms with various degrees of pathogenicity may lead to cross-infection and expose healthcare workers and patients to illness [2]. All prosthetic devices and dental equipment must be thoroughly cleaned to prevent cross-contamination [3].

Denture cleansers are a popular method used by denture wearers for cleaning; there are wide varieties of denture cleansers used to remove soft food and hard deposits of calculus and stains on denture base and teeth; the most common of them are mechanical and chemical procedures [4]. Brushing with a toothbrush with toothpaste, soap, or cleansers underwater is a well-known technique for mechanically removing plaque [5]. However, this procedure is usually used by patients, and it is insufficient for cleaning undercut sections of dentures, which might harbor bacteria. Furthermore, aged patients with weak motor coordination and handicapped patients with low physical ability and a lack of cooperation may not clear the accumulated biofilm appropriately [1], while denture hygiene is improved with the introduction of chemical cleaners such as sodium

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hypochlorite solutions, denture washing tablets, and mouthwashes like chlorhexidine gluconate [6].

Ozone, represented by the chemical symbol "O3," is a naturally occurring gaseous molecule composed of 3 atoms of oxygen. The term ozone derives from the Ancient Greek word ozein, which means "odor [7]. Previous research has demonstrated that ozone can efficiently clean denture [8–10]. Home ozone generators modest amounts of aqueous ozone, which can efficiently eradicate bacteria and fungi [11]. When paired with mechanical means, ozone can be significantly more effective. Ozone is more convenient and cost-effective when compared to other chemical cleansers [9]. Ozone treatment is a diverse bio-oxidative therapy in which oxygen/ozone is delivered therapeutically as dissolved in water, oil, or gas [7].

Few studies have examined how ozone affects the mechanical and physical properties of polymethyl methacrylate (PMMA). Therefore, this research aimed to evaluate how an ozone water solution affects the surface hardness and roughness of polymethyl methacrylate.

2. Material and methods

2.1. Preparation of samples

The surface roughness and surface hardness testing specimens were prepared using an available bar-shape pattern with the following dimensions: 15 mm wide, 30 mm long, and 2.5 mm thick [12]. This pattern was placed in metal flasks containing type IV additional dental stones (Lascod). The test specimens were created in the resulting mold space. After setting, the flask halves were separated. The acrylic resin (Ivoclar Vivadent AG) was mixed according to the manufacturer's instructions, then placed in the stone mold and flasked. The clamped flask was placed in the water bath at room temperature, the water bath was opened, the temperature was raised to 70 °C for 7 h (following the standard polymerization of Ivoclar Vivadent AG), the water was heated again until it reached 100 °C, and the flask was maintained at this temperature for 45 min, the metal flasks were allowed to cool gradually at room temperature for 30 min following the curing procedure before being opened [13]. After that, all specimens were finished and polished.

2.2. Sample group

Groups (OZ-10): The samples were soaked in ozonated water for 10 min at (2 mg concentration of ozone in water).

Group (OZ-20): the samples were soaked in ozonated water for 20 min at (2 mg ozone concentration in water).

Groups (C): specimens were soaked in distal water (control group).

2.3. Preparation and immersion of denture cleanser

A home air ozone generator (Multifunctional Ozonizer and Fruit and Vegetable Detoxification Washer, China) was used to prepare the ozonized water. The output tube was put in a glass beaker with 1000 ml of deionized distilled water. The ozone was then bubbled for 30 min through the water. A CLEANS30 portable dissolved ozone meter was used to measure the concentration of dissolved ozone in the water (CS6930 dissolved ozone electrode., China).

The surface hardness and surface roughness of all samples were measured following immersion in ozonated water solutions for groups (OZ-10) and (OZ-20), while the control group (C) was soaked only in distilled water.

2.4. Hardness test

A shore D hardness tester was used to measure the specimens' indentation hardness. The force has been set at 50N, which is suitable for use with acrylic resin. For accurate results, the shore hardness tester's contact surface must be parallel to the test stand's specimen support. The hardness tester's indenter was set 5–12 mm away from the specimen's surface. The measurements were taken instantly from the scale reading after the specimen had been in contact with the indenter for 6 s. Each specimen had three different measurements recorded at different locations, and an average was then determined.

2.5. Roughness test

Microgeometry was investigated using the profilometer instrument (surface roughness test) [14]. A surface analyzer (sharp stylus) is included with this device to capture all the peaks and recesses that define the surface as well as trace the profile of surface imperfections (Surface roughness was measured and recorded before and after immersion in the ozone water solution and distilled water).

Following the recording of the surface roughness value, all of the samples were submerged in the ozone water solution (each sample in its particular group, as mentioned earlier), except for group (C) samples, which were just immersed in distilled

water. After that, a second surface roughness measurement was recorded, which was considered the after immersion value. And it was determined and computed how much difference there was between the two readings taken before and after immersion.

3. Result

3.1. Hardness test

Vickers hardness tester readings were obtained three times for each specimen examined to assess the acrylic resin's indentation hardness. Fig. 1 shows the average and standard deviation of these readings. Based on the results of this test, groups [3] have the highest average resistance to indentation, followed by groups [1] and then groups [2].

Table 1 displays the results of a one-way analysis of variance (ANOVA) test, revealing a statistically significant difference between the three groups.

There is a statistically significant difference only between groups (C) and groups (OZ-10) according to the results of the repeated Games–Howell tests; at the same time, there is no significant difference between groups (C) and groups (OZ-20) as well as between group (OZ-10) and group (OZ-20) as listed in the Table 2.

3.2. Surface roughness

The average surface roughness for the three groups is shown in Fig. 2. The average of the samples soaked in the ozonated water is nearly the same as the average of the samples soaked in distilled water.

Table 1. The ANOVA tests were used to compare the hardness of the 3 groups.

	Sum of Squares	DF	Mean Square	P-value	Sig
Between Groups	7.731	2	3.866	0.034	S
Within Groups	27.108	27	1.004		
Total	34.839	29			

S: significant.

As demonstrated in Table 3, There were no statistically significant differences among the groups studied, according to the ANOVA test.

4. Discusion

Ozone is an alternative disinfectant in dentistry due to its considerable antibacterial efficacy and absence of medication resistance [15]. According to Bezirtzogl et al., using ozone for a short time had a bacteriostatic impact, but using ozone for more than 30 min had a bactericidal effect; They also discovered that aqueous ozone has a limited half-life, which means that the remaining ozone can only survive in water for up to 80 h [16]. It is hard to produce ozone and keep it for long periods; in most cases, they found that aqueous ozone had a lower level of cytotoxicity compared to gaseous ozone as well as well-known antimicrobials (2 and 0.25 percent chlorhexidine gluconate; 5 and percent sodium hypochlorite; 3 percent hydrogen peroxide) Additionally, it is believed that the ozonated water seems to be more physiologically friendly for oral administration [17].

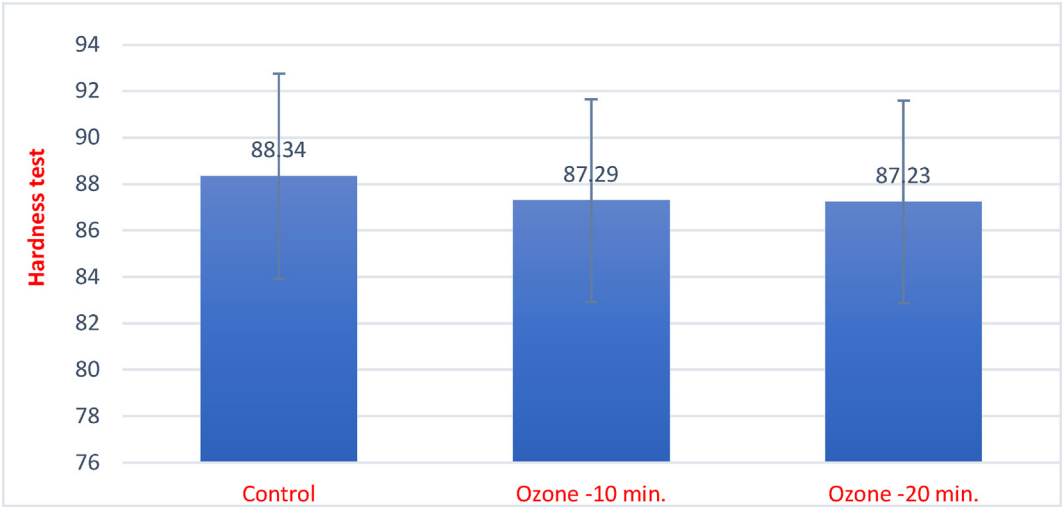

Fig. 1. Bar chart of surface hardness between the studied groups.

Table 2. Multiple comparisons of Games–Howell results across all research groups.

Groups	Mean difference (I-J)	p -value	Sig
Control -ozone 10 min	1.0440	0.025	S
Control -ozone 20 min	1.1070	0.076	NS
Ozone 10 min -ozone 20 min	0.0630	0.992	NS

S: Significant.
NS: non-significant.

Table 3. The ANOVA test of roughness between the three groups.

	Sum of Squares	df	Mean Square	P value	Sig
Between Groups	0.000	2	0.000	0.984	NS
within Groups	0.075	27	0.003		
Total	0.076	29			

NS: non-significant.

The rough surface may be characterized by minute indentations or irregularities, affecting the surface's overall material quality [18,19]. One of the primary goals of resin restoration is to achieve a smooth surface free of or with excellent surface scratches, as increased surface roughness hurts denture aesthetics, whereas a smooth, shiny surface can resist stain, debris, and plaque buildup [20].

In the current research, the result of the profilometer was statistically non-significantly different between the tested samples that soaked in ozone water and those socked in distilled water; possible explanations for this result may be the effect of solution, ozone water may be used to clean polymethacrylate without affecting the alloy's physical qualities, such as reflectance, surface roughness, and weight [7]. Also, short durations of submerging in cleansers did not substantially enhance the roughness surface; while, more prolonged periods of immersion might contribute to increased surface roughness, this proved by Jeyapalan., et al. [21]. The outcomes in this study agree with previous research that wrote by Hamada, Alam-Eldein and Shorbagy in 2022, who found that both ozonized water and alkaline peroxide had no negative effect on the surface roughness of PMMA [22]. In contrast, Abdallah and Aref, in 2020, reported that the disinfection of PMMA denture base resin with ozonated water increased the degree of surface roughness [17].

Hardness is the material's resistance to plastic deformation, typically measured under an indentation load. It is a measure of the resistance to wear or scratching [23]. In the present study, surface hardness decreased statistically significantly after (10–20 min) immersion compared to the control group; possible explanations for this decrease includes the ongoing polymerization reaction, monomer release, and the coupling of monomers with free active radicals via connecting with free oxygen [24]. The findings may also be explained by the fact that disinfection may act as a plasticizer, enabling tensions produced during processing to relax, resulting in a decrease in surface hardness [25]. The result of this study coincides with research that observed by Ozyilmazand, Kara, and Akin in 2019, which indicated that the hardness of heat cured significantly decreased when it was immersed in denture cleansers such as Corega, Protefix,

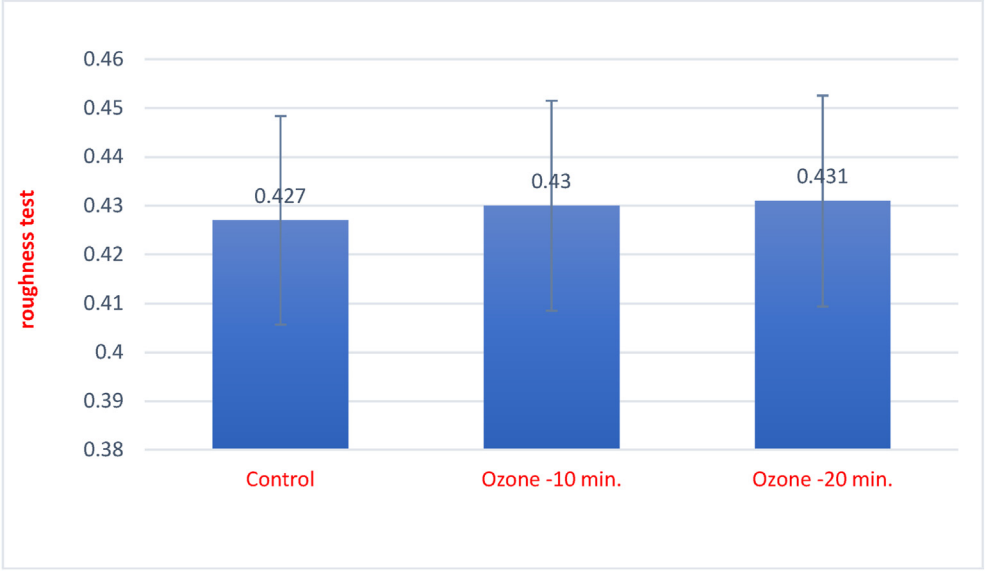

Fig. 2. Bar chart of surface roughness between the studied groups.

Curaprox, and Perlodent, independent of the kind of cleanser [1]. At the same time, this is in disagreement with Pererira et al. in (2019) found that immersion of samples in vinegar disinfectant solution, 1% sodium hypochlorite, and hydrogen peroxide for a long and short period didn't affect surface hardness [26]. Moreover, this result disagrees with the study that was written by Abed in 2022, which indicated that surface hardness was not affected when samples were immersed in electrolyzed water at 100 and 200 ppm concentrations for 5 min, 30 times per day [27].

Finally, it's important to remember the different ways that roughness and hardness were measured, and the different types of heat cure acrylic resin used to make it challenging to compare roughness and hardness values from various studies.

It is important to ask the patient to use an ozonated water rinse twice daily for seven days. This aids in the recovery of oral lesions such as candidiasis, aphthous ulcers, and cheilitis [28].

5. Conclusion

The following results were found in this study:

- Roughness values in heat-cured acrylic resin samples were not significantly affected by the immersion in ozonized water for (10 and 20) minute at 2 mg/l concentration compared with distal water.
- Statistically, the surface hardness values of specimens disinfected with ozonized water significantly differed from those treated with distal water. but within clinically acceptable at 2 mg/L concentration.

References

[1] Fatalla AA, Tukmachi MS, Jani GH. Assessment of some mechanical properties of PMMA/silica/zirconia nanocomposite as a denture base material. InIOP Conference Series: Materials Science and Engineering 2020 Nov 1 (Vol. 987, No. 1, p. 012031). IOP Publishing.

[2] Abass SM, Ibrahim IK. The effect of addition of calcium hypochlorite disinfectant on some physical and mechanical properties of dental stone. Scientific Journal Published by the College of Dentistry—University of Baghdad; 2012:36.

[3] Ellakwa AE, El-Sheikh AM. Effect of chemical disinfectants and repair materials on the transverse strength of repaired heat-polymerized acrylic resin. J Prosthodont 2006 Sep;15(5): 300–5.

[4] Salem SA, Al-Khafaji AM. The effect of prepared denture cleansers on some physical properties of stained acrylic resin denture base material cured by two different techniques. Scientific Journal Published by the; 2006. p. 1.

[5] Degirmenci K, Hayati Atala M, Sabak C. Effect of different denture base cleansers on surface roughness of heat polymerised acrylic materials with different curing process. Odovtos Int J Dent Sci 2020 Dec;22(3):145–53.

[6] Tripathi P, Phukela SS, Yadav B, Malhotra P. An in vitro study to evaluate and compare the surface roughness in heat-cured denture-based resin and injection-molded resin system as affected by two commercially available denture cleansers. J Indian Prosthodont Soc 2018 Oct;18(4):291.

[7] Alpana T, Ullah K, Kumar RA. Ozone therapy-A boon to dental sciences. Ind J of Forensic Med & Toxicol 2021 Mar 24; 15(2):47–51.

[8] Arita M, Nagayoshi M, Fukuizumi T, Okinaga T, Masumi S, Morikawa M, et al. Microbicidal efficacy of ozonated water against Candida albicans adhering to acrylic denture plates. Oral Microbiol Immunol 2005 Aug;20(4):206–10.

[9] Murakami H, Mizuguchi M, Hattori M, Ito Y, Kawai T, Hasegawa J. Effect of denture cleaner using ozone against methicillin-resistant Staphylococcus aureus and E. coli T1 phage. Dent Mater J 2002;21(1):53–60.

[10] Nagayoshi M, Fukuizumi T, Kitamura C, Yano J, Terashita M, Nishihara T. Efficacy of ozone on survival and permeability of oral microorganisms. Oral Microbiol Immunol 2004 Aug;19(4):240–6.

[11] Mirmortazavi A, Haghi HR, Fata A, Zarrinfar H, Bagheri H, Mehranfard A. Kinetics of antifungal activity of home-generated ozonated water on Candida albicans. Curr Medi Mycol 2018 Jun;4(2):27.

[12] Salem S, Al-Khafaji AM. The effect of denture cleansers on surface roughness and microhardness of stained light cured denture base material. J Bagh Col Dentistry 2007;19(1):1–5.

[13] Salih HA, Abdul-Ameer FM. The effect of incorporation kappa-carrageenan powder on the physical and mechanical properties of the heat-cured acrylic-based soft denture lining material in clinical use. Indian J Forensic Med Toxicol 2020 Oct 29;14(4):2102–10.

[14] Turki MM, Abdul-Ameer FM. Influence of silver nanoparticles on the specific properties of acrylic resin for ocular prosthesis. Biomed and Pharmac J 2018 Sep 21;11(3): 1573–81.

[15] Seydanur Dengizek E, Serkan D, Abubekir E, Aysun Bay K, Onder O, Arife C. Evaluating clinical and laboratory effects of ozone in non-surgical periodontal treatment: a randomized controlled trial. J Appl Oral Sci 2019 Jan 14:27.

[16] Bezirtzoglou E, Cretoiu SM, Moldoveanu M, Alexopoulos A, Lazar V, Nakou M. A quantitative approach to the effectiveness of ozone against microbiota organisms colonizing toothbrushes. J Dent 2008 Aug 1;36(8):600–5.

[17] Abdallah RM, Aref NS. An in vitro assessment of physicomechanical properties of heat-cured denture base resin disinfected by ozonized water. World J Dent 2020 Aug 1; 11(2):146–50.

[18] Al-Dwairi ZN, Tahboub KY, Baba NZ, Goodacre CJ, Özcan M. A comparison of the surface properties of CAD/CAM and conventional polymethylmethacrylate (PMMA). J Prosthodont 2019 Apr;28(4):452–7.

[19] Cortés-Sandoval G, Martínez-Castañón GA, Patiño-Marín N, Martínez-Rodríguez PR, Loyola-Rodríguez JP. Surface roughness and hardness evaluation of some base metal alloys and denture base acrylics used for oral rehabilitation. Mater Lett 2015 Apr 1;144:100–5.

[20] 11Zaidan NM, Jassim RK. Effect of microcrystalline cellulose incorporation on some properties of heat cured acrylic denture base material. MSc thesis. University of Baghdad; 2022.

[21] Jeyapalan K, Kumar JK, Azhagarasan NS. Comparative evaluation of the effect of denture cleansers on the surface topography of denture base materials: an in-vitro study. J Pharm BioAllied Sci 2015 Aug;7(Suppl 2):S548.

[22] Hamada M, Alam-Eldein A, Shorbagy Z. The effect of ozonised water versus alkaline peroxide cleaners on colour stability, surface roughness and hardness of two different denture base materials. Egypt Dent J 2022 Jul 1;68(3): 2613–24.

[23] Jasim BS, Ismail IJ. The effect of silanized alumina nanofillers addition on some physical and mechanical properties of heat cured polymethyl methacrylate denture base material. J Bagh Col Dentistry 2014;26(2):18–23.

[24] Porwal A, Khandelwal M, Punia V, Sharma V. Effect of denture cleansers on color stability, surface roughness, and hardness of different denture base resins. J Indian Prosthodont Soc 2017 Jan;17(1):61.
[25] Moussa AR, Dehis WM, Elboraey AN, ElGabry HS. A comparative clinical study of the effect of denture cleansing on the surface roughness and hardness of two denture base materials. Open access Macedonian J Med Sci 2016 Sep 9; 4(3):476.
[26] Pereira CJ, Genari B, Leitune VC, Collares FM, Samuel SM. Effect of immersion in various disinfectant solutions on the properties of a heat-cured acrylic resin. RGO-Revista Gaúcha de Odontologia 2019 Oct 28:67.
[27] Abed AA. The effect of electrolyzed water on some properties of polyamide and heat cured acrylic resin. MSc thesis. University of Baghdad; 2022.
[28] Sen S, Sen S. Ozone therapy a new vista in dentistry: integrated review. Med Gas Res 2020 Oct;10(4):189.