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Original article

Effectiveness of Different Denture Disinfectant Agents on The Flexural Strength of Heat Cured Acrylic Denture Base

Mohamed Elmaroush[1], Suleiman Elsayah[2], Sarra Benhamida[1]*, Saad Ghidhan[3]

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[1]Department of Prosthodontics Faculty of Dentistry University of Tripoli, Tripoli, Libya.
[2]Department of Health, Faculty of Science, University of Elmergab, Alkhoms, Libya.
[3]Department of Mechanical and Industrial Engineering, University of Elmergab, Alkhoms, Libya.
***Correspondence.** aishsarra@yahoo.com*

Abstract

This study was carried out to investigate the effects of three commercially available and commonly used denture disinfectant agents on the flexural strength of a conventional heat cure acrylic denture base. A total of 24 specimens were fabricated from the conventional type of heat cure acrylic resin, divided into 4 groups (n=6) according to their immersion in different types of denture disinfectant agents. group1: Distilled water (control), group 2: 2.5% sodium hypochlorite, group 3: Disinfectant tablet (Corega tabs), and group 4: Solution of 100% cica vinegar. The samples were immersed for 15 minutes a day for 15 days, the flexural strength was measured. The data was statistically analyzed using ANOVA test and Tukey's HSD test with $p \leq 0.005$. The results of this study showed that the solution type did not result in a significant difference in the mean flexural strength of heat cured acrylic denture base. Within the limitations of this study, the results demonstrate that the use of denture disinfectant agents can be advantageous in maintaining the quality and longevity of denture bases. As they have minimal adverse effect on the flexural strength.

Keywords: *Different Denture, Disinfectant Agents, Heat Cured Acrylic Denture Base.*

Important factors contributing to the success of prosthodontic restorations are the skills of the prosthodontics and the dental technician. Moreover, the equal important is placed on the proper selection of the desired denture base resin [1]. Since the introduction of acrylic resin as a denture base material in 1937 by Dr Walter Wright, revolutionized the discipline of dental prosthetics to a great extent. The acrylic resin has maintained its superiority over other denture base materials meeting with the requirements of an ideal denture base material [2]. Clinically, within the intraoral environment, dentures are exposed to thermal changes from food consumption, in addition to biofilm development and bacterial colonization on denture surfaces [3].

After delivery of dental prosthesis, patients should be advised and given instructions on denture care [4]. Home care instructions provided to the patients during the appointment of denture insertion help in the maintenance of oral mucosal health [5].

There are three methods advocated for cleaning dentures that includes mechanical, chemical and combination of both. Mechanical method is routinely and widely used by patients although many elderly patients are not able to apply it because of their lack of compliance or poor motor coordination. Thus, for biofilm removal on prosthesis surfaces for such patient's usage of chemical denture disinfectant becomes a viable option [6]. Also, the application of chemical cleanser is typically linked to mechanical methods, and their effectiveness in eliminating stains and minimizing biofilm formation on the dentures surface have been reported [7].

Sodium hypo chlorides (NaOCl), vinegar and the alkaline peroxides are the active ingredients in the two main classes denture cleansers [8,9]. Moreover, vinegar is commercially available, it typically has an acid content of 5%. Besides its application as a culinary ingredient, it has also been studied for the presence of bioactive compounds and antioxidant activity [10].

Ideally, disinfectant agents have antimicrobial properties; remove organic and inorganic biofilm, while having minimal effect on oral tissues [11]. Moreover, they should not alter the physical and chemical properties of the acrylic resin [12,13]. Paranhos et al [14] found that

the chemical composition of disinfectant and the immersion time play significant roles in changes in the acrylic resin over time. Ideally, the selected denture disinfectant agent should be compatible with the denture base material. In fact, in the patient's mouth, denture base acrylic resins are subjected to various types of stresses. The flexural or transverse strength are crucial for withstanding intraoral stresses, which include both compressive and tensile forces [15].

The overall lifespan of a dental prosthesis is influenced by the physical properties of the denture base resin, and the denture base polymers may experience clinical failure as result of flexural fatigue and end up with fracture. Among different physical properties that can be affected by use of denture disinfectant agent, flexural as well as fracture strength is of prime interest because clinical failure of denture base may occur as result of flexural fatigue [16, 17]. The objective of this study was to investigate the effects of three commercially available and commonly used denture cleansers on the flexural strength of a conventional heat cure acrylic denture base.

Methods

This in vitro study was carried out to evaluate the effect of different disinfectant agents on the flexural strength of the conventional heat cured acrylic denture base.

A total of 24 specimens were fabricated from heat cure acrylic resin (Trevalon, Dentsply India, Gurgaon), using wax die of 65 × 10 × 3 mm. Then the dental plaster was utilized to invest the wax pattern in a dental flask, ensuring that entrapment of air was avoided during investment process by using a mechanical vibrator. Dewaxing was carried out after 10 mins of the final set of the plaster and test samples were prepared using the mold space obtained. Separating media was used for painting the model in dental flask. Powder-liquid ratio for conventional type of heat cure denture base material is 24g/10ml. The material was mixed following the manufacturer's instructions and packed at dough stage. The samples were bench cured for 1 h and polymerized. Processing was carried out, the samples were bench cooled for 1h, and sand papering was done followed by polishing with pumice. Manual caliper and ruler were used to verify the length, width, and thickness of each sample (fig 1) and then the samples were stored in distilled water for 24 hours for residual monomer elimination [8].

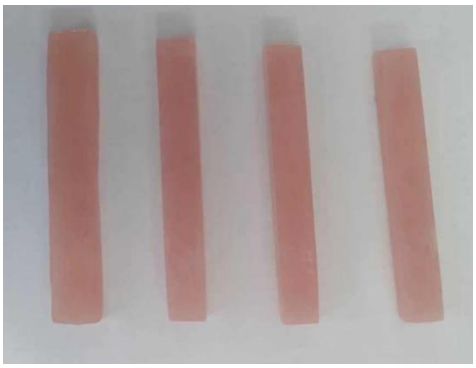

Figure 1. Samples of heat cure acrylic resin blocks

The Samples were randomly divided into the four experimental group (n = 6). Distilled water (control group). 2.5% sodium hypochlorite solution. Corega Tabs (Block Drug Company, Inc., USA). Solution of 100% cica vinegar.

All samples were immersed 15 minutes a day for 15 days. This protocol was designed similar to the daily used dentures by the patients. After 15 days, the flexural strength of the all samples was measured using three-point flexural test in accordance to ASTM D790-86. The support span was set at 50 mm. Test was conducted at a crosshead speed of 2 mm/min on a universal testing machine (UTM Hounsfield, H5KS, England) (fig 2). At least five samples for each formulation were tested. The flexural strength was assessed using the following equation:

$$\text{Flexural strength} = \frac{3PL}{2bd^2}$$

Whereby L = Span length, P = Maximum load, b = Specimen width, d = Specimen thickness.

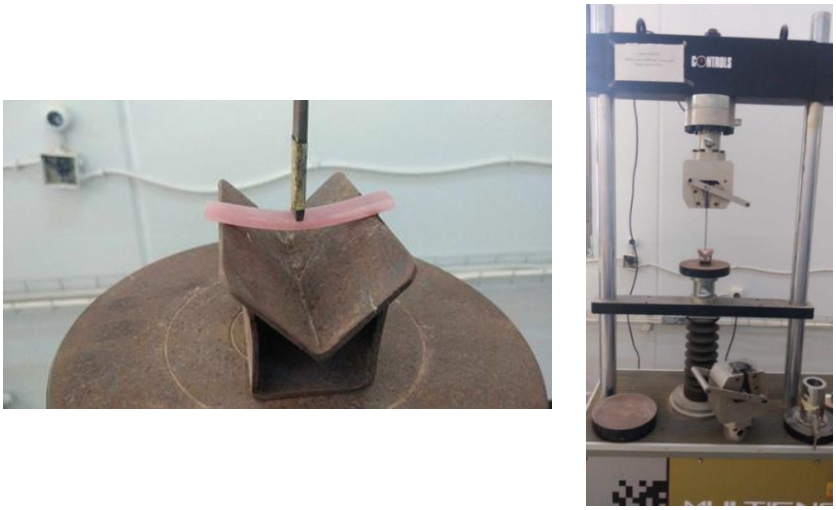

Figure 2. Flexural strength of the samples was measured using a universal testing machine.

Data was collected and prepared in an electronic database for statistical analysis using SPSS version 23.0 (IBM USA). Data were analyzed with one-way ANOVA, and multiple comparisons were undertaken using Tukey's HSD test. Statistical significance was set at $P \leq 0.05$.

Results

The flexural strength of conventional heat cured acrylic denture base was measured after immersed in four different disinfectant agents for fifteen days.

Table 1, presents the descriptive data and statistical analysis on the ANOVA test. According to the Table, heat cured acrylic denture base that was immersed in vinegar solution exhibited the highest flexural strength (122.22 ± 4.8 MPa); while the heat cured acrylic denture base that was immersed in sodium hypo chloride exhibited the lowest flexural strength (72.22 ± 24.1 MPa).

The mean values were compared between the different groups separately in each liner with the use of one-way ANOVA. The results showed that the solution type did have a significant difference in the mean flexural strength Table 1 and (fig 3).

There were no significant differences between distilled water with Vinegar solution and Tablet ($P < 0.869$ and $P < 0.468$ respectively), while there was a significant difference between distilled water and NaoCl ($P < 0.022$). There was no significant difference between Vinegar solution and Tablet ($P < 0.181$). However, there was significant difference between Vinegar solution and NaoCl ($P < 0.008$). There were significant differences between NaoCl with Vinegar solution and distilled water ($P < 0.008$ and $P < 0.022$ respectively). While Tablet showed no significant differences between all tested groups distilled water, Vinegar and NaoCl ($P < 0.468$, $P < 0.181$ and $P < 0.181$ respectively.

Table 1: The descriptive statistics of the flexural strengths in the different study groups

Groups	Mean	SD	P
Distilled water	113.88	4.81	P =0.08
Sodium hypo chloride	72.22	24.10	
Disinfectant tablet (Corega tabs)	97.22	9.62	
Cica vinegar	122.22	4.82	

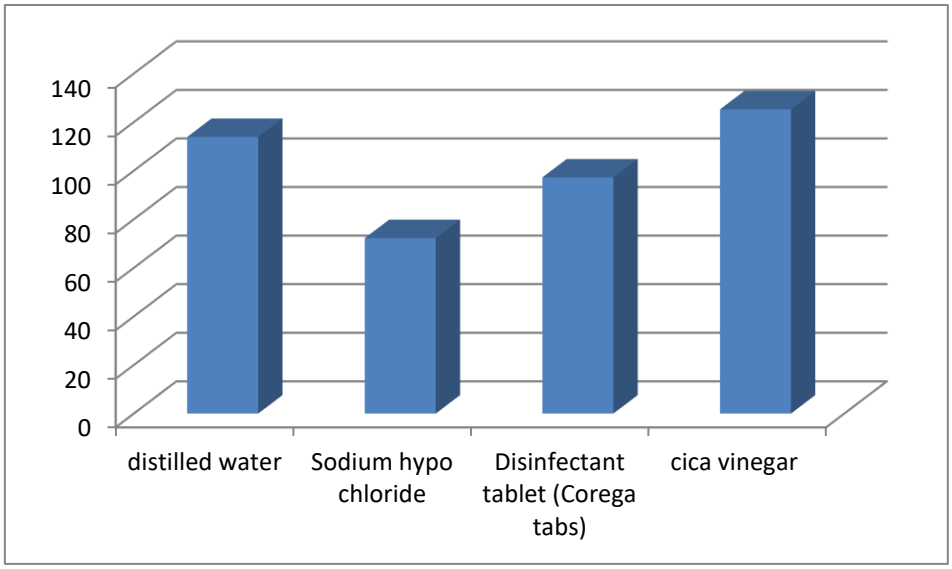

Figure 3. Comparison between the different groups according to the flexural strength.

Discussion

Denture base fracture has been found to be one of the most common factors of denture failure. During mastication, a load applied through the teeth of a denture forces the base against the hard tissue of the mouth. Stress analysis has indicated that flexural stresses mainly occur in maxillary base adjacent to supporting tissues. Elsewhere, flexural and transverse strength are important and desirable properties of the material of denture base to have optimum function of prosthesis [18].

The present research was carried out to assess impact of different disinfectant solutions on the flexural strength of the conventional heat cure acrylic denture base.

The results of this study demonstrated that there was no significant difference among the three disinfectant agents. Although these results were in agreement with the previous studies which evaluated the impact of chemical disinfectants on transverse strength of heat polymerized acrylic resin submitted to chemical and mechanical polishing [19, 20]. Moreover, Pavarina et al [2003] stated that the flexural strength of the two-heat cured denture base acrylic resins stay unaffected after being soaked in the three disinfectants solutions for 10 minutes (4% chlorhexidine, 1% sodium hypochlorite and 3.78% sodium perborate) [21]. In accordance with those of Asad et al, (1992) who found that the use of 0.5% chlorhexidine did not significantly affect the flexural strength of a denture base acrylic resin after 7-days immersion [22].

However, our study showed that heat cured acrylic denture base that immersed in sodium hypo chloride exhibited the lowest flexural strength, it has been shown that at 0.5% concentration, sodium hypochloride cleansers cause no structural changes to the dentures, but do provide clinically effective antibacterial and antifungal properties [23, 24]. These results counteract with the previous studies which conclude that increase in concentration sodium hypochloride above 0.5% results in discoloration, denture roughness and structural weakness of acrylic denture base [23-25].

Moreover, previous studies had been showed that heat-polymerising resins are more susceptible to fracture after being soaked in cleansers [26, 27]. Moreover, other studies showed that even the immersion of acrylic denture base on a water can cause adverse effect on its strength as the polymethyl methacrylate absorbs relatively low amounts of water after immersion in aqueous medium. Water molecules interfere with the polymer chains and act as a plasticizer and that may lead to adverse effects on mechanical properties [28], that effect mainly depends on the immersed time.

In a study by Al-takai, [2014] that evaluates the impact of vinegar, salt, and chlorhexidine disinfectant solutions on the flexural strength of acrylic base denture resin. The samples were soaked in solutions for one week, one month, and three months, found that the flexural strength of resin samples immersed in vinegar decreased the flexural strength [29]. The reason of this finding could be that the vinegar is a mild acid, smoothens the surface layer of the materials, reduces interchain forces, and ultimately decreases the tensile strength of the resin that ultimately depend on the immersion time as well as the concentration of the disinfectant agents.

In this study, the flexural strength of conventional acrylic denture base was evaluated after short-term immersion in disinfectant solutions. However, the dentures may undergo multiple disinfection processes throughout their lifespan. So, long-term evaluation of acrylic denture base flexural strength after immersion in disinfectant solutions is recommended.

Conclusion

Within the limitations of this study, the results demonstrate that the use of denture disinfected agent can be advantageous in maintaining the quality and longevity of denture bases, as they have minimal adverse effect on the flexural strength.

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