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RESEARCH ARTICLE - MEDICAL TECHNIQUES

Influence of Different Disinfectants on Surface Hardness of Heat-Polymerized Acrylic Resins utilized for Orthodontic Appliance

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Abstract

Heat-polymerized resins are common substances utilized for construction of removable dental prostheses (i.e. Orthodontic appliances). Such materials should have appropriate physical properties. The use of disinfectant solutions might influence the physical characteristics of the acrylic materials. This study was conducted to assess the influence of different disinfectants on heat polymerized resins in terms of surface hardness. Forty specimens were made from heat-polymerized acrylic resins in total. The investigation comprised 4 groups according to the disinfectants utilized and each group had ten specimens. The 1st group was immersed in distilled water (control); the 2nd group was disinfected in Efferdent; the 3rd group was disinfected in 4 % Chlorhexidine; and the 4th group was disinfected in 1% hypochlorite. All specimens were tested via a hardness tester three times and the average reading was measured for all specimens. The statistical results indicated a slight decline in the mean values of surface hardness of acrylic specimens following immersion in disinfectants. The greatest value of mean was for distilled water specimens whereas the lowest value of mean was for 4% Chlorhexidine specimens. Furthermore, no significant differences were found among all groups ($P>0.05$). The study concluded that the use of disinfectants solutions slightly decreases the hardness of heat polymerized resins. It is recommended to evaluate the chemical interaction between the acrylic resins and disinfectants.

Keywords: different disinfectants; surface hardness; acrylic resin.

1. Introduction

In removable prosthodontics, heat-polymerized acrylic resins are materials widely utilized for the construction of removable appliances because of their appropriate properties such as excellent aesthetic properties, easy of repair and manipulation, reasonable in price, etc. [1,2]. Orthodontic appliances are part of orthodontic treatment and utilized for short or long terms to move or retain the teeth [3,4]. Such appliances are considered as a foundation of cross contamination between the dental staff and patients. During their use, they can be colonized and infected by microorganisms, which may spread either via direct contact or through the aerosol produced during finishing and polishing procedures [5,6]. Microorganisms can result in a variety of illnesses (i.e. Hepatitis B, Herpes, Tuberculosis and acquired immunodeficiency syndrome). The appliances must be, therefore, disinfected before used by the patients [7,8]. The goal of soaking a denture in disinfectants is to disable the action of viruses, bacteria, and fungi [9]. The common chemical disinfectants for dental appliances include glutaraldehyde, sodium hypochlorite, and chlorine dioxide [10,11,12]. The disinfectant solutions could diminish the amount of microorganisms on the surface of the dental prosthesis [13,14]. The disinfectants should preserve the properties of the acrylic resins (i.e. physical, mechanical and surface properties) [15]. According to the literature, the use of disinfectants has had an adverse effect on acrylic properties such as flexural strength, surface roughness, surface hardness [16-19]. Hence, this research was undertaken to assess the effect of using different disinfectants on acrylic resins in terms of surface hardness. The null hypothesis imposed that the surface hardness would be not influenced by disinfectant solutions.

2. Materials and methods

2.1. Samples grouping

In the current research, 40 specimens of the acrylic resins (Veracril, New Stetic S.A. -Colombia) were prepared in total according to different disinfectants used. There were four sets; the first set was the distilled water (control); the second set was disinfected in Efferdent (Pfizer

Consumer Health, USA). The third group was disinfected in 4 % Chlorhexidine (Manipulation Pharmacy, Apothicario, Brazil). The fourth group was disinfected in 1% hypochlorite (Manipulation Pharmacy, Apothicario, Brazil).

2.2. Fabrication of acrylic specimens

For hardness test, plastic patterns (65 mm length, 10 mm width and 3mm thickness) were used to make the acrylic specimens [20]. The procedure comprised the lubrication of 2 halves of the flask with Vaseline(China) to remove the acrylic specimens easily from the mould after deflasking. According to the instructions provided by the manufacturers, Zhermack dental stone (Italy) and water are mixed and then poured into the lower part of the flask after receiving a creamy state. Plastic strips were then carefully placed in the middle as shown in the Fig 1.

Fig. 1. Stone mold and plastic patterns

After complete set of stone surface, the patterns and stone surface were coated with the separating medium (Zinnfoile, Dentaurum Pforzheim, Germany). The upper part was placed into its correct situation. Another mix of water and dental stone was then prepared and poured over the patterns and stone surface and left for 1 hour to set. Afterward, the 2 halves were opened carefully; and patterns taken away, and cleaned with detergents. The separating medium (tinfoil, Zinnfoile,Germany) was then applied and left to dry (Fig. 2).

Fig. 2. Stone mould

The acrylic specimens were made via mixing the acrylic powder and monomer liquid with a ratio of 3:1. At dough stage, the acrylic was packed into mould, and then cured according to guidelines supplied by manufacturers. Subsequently, the mould was taken away from the waterbath machine, and left to cool. After that, acrylic specimens were taken away from stone mould, finished and polished via traditional method. All specimens were kept in saline solution with a temperature at 37 C in order to hydrate them [21]. All specimens were then disinfected in different solutions for 60 days. Chlorhexidine and hypochlorite specimens were daily disinfected using a manual friction using a gauze for 60 seconds. Then the specimens were rinsed in running water for thirty seconds [22]. The Efferdent specimens were washed 3 times a week where the cleaning included the immersion of the specimens into distilled water solutions having an effervescing tablet at a temperature of 37°C for fifteen minutes, then rinsed in running water for thirty seconds [23].

2.3. hardness test

The hardness tester (Shore D, Italy) was utilized to test the acrylic specimens. The surface of each specimen was exposed to a load of fifty grams for 10 seconds 3 times (left, middle, right). Then, the average reading was recorded (Fig. 3).

Fig. 3. Specimen under hardness tester

3. Results

The specimens were analyzed statistically via SPSS *v* .20. The results indicated a slight fall in the mean values of surface hardness of the acrylic specimens after soaking in different disinfectants as demonstrated in Table (1). More specifically, 4% Chlorhexidine specimens had a lower mean value of surface hardness compared to the other groups. Whereas distilled water specimens had the highest mean value of surface hardness. Furthermore, no significant differences were seen among all groups where $P>0.05$ as illustrated in Tables 2 &3.

Table 1. Descriptive statistics of all groups

groups	No.	Mean	Standard deviation
Distilled water	10	100.67	1.51
Efferdent	10	99.56	1.51
1% Hypochlorite	10	99.40	1.50
4% Chlorhexidine	10	99.19	1.51

Table 2. Tukey comparison test

Groups	P value	sig
Distilled water - Efferdent	.374	Non-significant
Distilled water – 1%Hypochlorite	.258	Non-significant
Distilled water -4% chlorhexidine	.147	Non-significant
Efferdent- 1% Hypochlorite	.995	Non-significant
Efferdent- 4%chlorhexidine	.946	Non-significant
1%Hypochlorite- 4%chlorhexidine	.989	Non-significant

Table 3. One-way ANOVA test results

ANOVA

hardness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.022	3	4.341	1.899	.147
Within Groups	82.301	36	2.286		
Total	95.323	39			

4. Discussion

In dentistry, heat-polymerized acrylic resins are frequently utilized for construction of the orthodontic appliances. Theses appliances could be contaminated by microorganisms, which could be transmitted from patients to dental staff. Therefore, infection control procedure is recommended for cross infection at the clinic. The orthodontic appliances should be disinfected properly since they are potential sources of transmitting the microorganisms. The use of disinfectants might affect the properties (i.e. physical and mechanical properties) of acrylic resins. Hence, the objective of this study was to assess the impact of different disinfectants on the hardness of acrylic resins which utilized for orthodontic appliances. In the current study, there were 4 groups according to disinfectants used (control, Efferdent, chlorhexidine and hypochlorite). The results indicated that there was a slight decline in the surface hardness following immersion the acrylic specimens in disinfectants solutions. The current results were supported by Neppelenbroek *et al*., [19], Moreno *et al.*, [24] and Carvalho *et al*., [25]. They revealed that the disinfectants performed as plasticizers in acrylic resin which would decrease the acrylic resins surface hardness.

5. Conclusion

The research was conducted to assess the influence of different disinfectants on heat-polymerized acrylic reins in terms of surface hardness. It is concluded that the disinfectants reduce slightly the acrylic resins surface hardness. Further investigation is recommended to assess the impact of different disinfectants on acrylic resins in terms of surface roughness, impact strength and color stability.

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