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EFFECTIVENESS OF DIFFERENT CHEMICAL CLEANSERS AND DISINFECTANTS ON THE TRANSVERSE STRENGTH OF DIFFERENT DENTURE BASE MATERIALS

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ABSTRACT

Denture wearers are strongly urged to practice regular oral and denture hygiene to maintain good oral and general health. Denture cleansing by chemical agents is an easily practiced method that requires simply the immersion of the denture in a commercially available solution according to the manufacturer's instructions. In selecting a disinfectant for dental prosthesis, compatibility between the disinfectant and the type of denture base material must be considered to avoid adverse effects in it. The aim of this study is to evaluate the effect of over the counter denture cleansers on the transvers strength of three denture base materials. Heat cure acrylic rein, self cure acrylic rein and the Thermoplastic groups specimens were immersed for one week (5 hours per a day) in peroxide effervescent denture cleansers (Corega Tabs, & Fittydent) and finally 2% Chlorhexidine. Distilled water was used as the control group. Transvers strength was measured using three-point bending test in a universal testing machine. Data were analyzed with ANOVA and Post-hoc Tukey's tests. The results showed multi variance analysis revealed high significance $p \leq 0.005$ for solutions and resin types, and the interaction of these factors on transverse strength. Conclusion: transverse strength of denture base material can be altered by the disinfectant solutions tested as well as by the type of resin.

KEYWORDS: Chemical cleansers, Disinfectants; Denture Base Materials; Thermoplastic; Transverse strength

INTRODUCTION

An ideal denture should have good dimensional stability, fracture resistance, esthetics and tissue compatibility and cause no allergic reaction[1,2]. Polymethyl methacrylate (PMMA) resin has a long, clinically established history for being utilised as denture base material, owing to its excellent aesthetic, adequate physical properties, reasonable coast and easy processing technique [3,4,5]. This material is available in two forms of heat-activated and chemically-activated based on the method of activation [6]. Conversely, some disadvantages have been described that affect the clinical performance of PMMA prosthetics such as dimensional

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inaccuracies, microbial adhesion, inadequate mechanical properties and allergic to monomer[7]. Considering the polymerization shrinkage of conventional heat-polymerized PMMA, a new injection molding technique was developed. Thermoplastic resins materials exhibit high creep and solvent resistance, excellent wear characteristics and high fatigue endurance. In addition, they have very little or almost no free monomer; therefore, they offer another option for allergic patients[8,9]. Clinically, in the oral environment, dentures are subjected to thermal alterations through food intake, besides the unavoidable biofilm development and bacterial colonisation on denture surfaces[10]. This colonisation is an important stage in the pathogenesis of denture stomatitis and other diseases not only for elderly and immune-compromised patients but also for healthy individuals[11]. Denture cleansing is essential to maintain the service ability of the denture, because of aesthetic concerns and for prevention of denture related stomatitis. Three methods are advocated for cleaning of dentures that includes mechanical, chemical and combination of both [12]. Chemical methods for cleaning dentures include soaking in a commercial solution [13]. The efficacy of chemical denture cleansers dislodging food debris, biofilm, and tobacco stains from dental prosthesis surface has been previously reported. [14]. Chlorhexidine is a widely used antiseptic and disinfectant acts by destroying cell membrane and precipitating the cell cytoplasm. It has a broad-spectrum efficacy and is much less irritating to tissue than other products [15]. Most commercially available disinfectants are composed of sodium hypochlorite and alkaline peroxides [16].

Peroxides are usually supplied as effervescent tablets and hydrogen peroxide solutions is formed upon dissolving in water [17]. Ideally, cleanser chosen should be compatible with the denture base material to be disinfected but studies have shown that the cleansers may alter the physical properties of denture base resin on prolonged used [18,19]; Contrary to it, few studies claim that cleansers if used according to manufacturer's instructions do not affect the physical properties[20,21]. Among various physical properties that can be affected by use of cleansers, flexural strength is of prime interest because denture base resins may fail clinically due to flexural fatigue [22,23].

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 thermoplastic denture base resin in comparison with a heat-polymerized PMMA acrylic resin and self cure acrylic resin.

MATERIALS AND METHODS

Total no of 48 rectangular shaped specimens were prepared for flexural strength test according to the international standers specifications. The specimens were divided into the following:

16 specimens of conventional heat-cured acrylic resin denture base materials. (Acrostone , Egypt)

16 specimens of self-cured acrylic resin denture base materials). (Acrostone, Egypt)

16 specimens of thermoplastic resin material (Vertex™ Thermosens, Vertex-Dental BV 3705HJ Zeist the Netherland).

Preparation of the Specimens: Mettalic mold having the dimensions of flexural strength test specimens according to the [American Dental Association; ADA Specification no. 12] for denture base polymer. (65 mm length× 10 mm width ×2•5 mm thickness) were constructed[24]. The manufacturers' instructions on mixing and packing were carefully followed. The heat-cured acrylic specimens were fabricated in the conventional manner. Polymerization was done in water bath at 70°C for7- 9 hours followed by 100°C for 30 minutes. The autopolymerized acrylic resin specimens were packed in the molds and the polymerization process was carried out at 25°C for 10 minutes.

Thermoplastic specimens were fabricated by the thermopress injection molding system (Vertex™ ThermoJect22). The preheating temperature was 290°C and the material injected with a pressure of 6.5 bars at 290°C according to the manufacturer's instructions [25]. All the specimens after deflasking, were finished and polished. Test specimens (heat-cured acrylic groups, self cure acrylic resin groups and the Thermoplastic groups) were randomly divided into 4 groups (n=4) The specimens were immersed for 1 week (5 hours per a day) at distilled water as a control group and 2 different alkaline peroxide effervescent denture cleansers (Corega Tabs, Fittydent) Sodium perborate monohydrate and 2% Chlorhexidine [26].

Preparation of solutions: Each denture cleanser solution was mixed according to manufacturer's instructions. One tablet of Corega denture cleanser tablets and Fitty Dent denture cleanser tablets were separately dropped into 100ml water to dilute. 100ml of the 2% Chlorhexidine was prepared at room temperature. Specimens were soaked in the various denture cleanser solutions for the previous periods, then they removed from the solutions , thoroughly washed in running water and stored in distal water. Transvers strength was measured using three-point bending test in a universal testing machine*. The force in Newten was applied perpendicular to the center of the Specimens[27]. (Figure 1) The transverse strength of all the specimen was calculated in MPa using the following equation:

Flexural strength (S) = 3PL/2bd2
L = length,
b = width of specimens,
d = thickness of specimens,
P = the load at fracture (N)

Data were analyzed by IBM SPSS software package version 20.0. ANOVA and Post-hoc Tukey's tests.were used[28, 29].

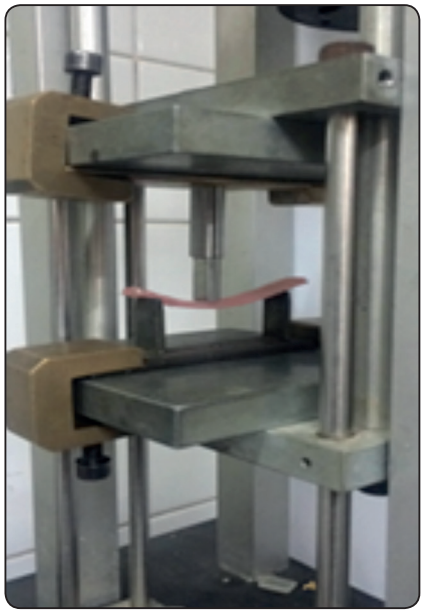

Fig. (1) Universal testing machine during testing

RESULTS

Flexural strength (MPa) means and standard deviations are shown in the Table 1. Significant differences in of flexural strength between the different chemical disinfectants and control group with heat cure acrylic resin material occurred at (p=0.012)

In table 2 no significant change for flexural strength among any group between the different chemical disinfectants and control group with self cure acrylic resin material.

In table 3 significant differences of flexural strength between the different chemical disinfectants and control group with thermoplastic resin material.

The studied materials treated with fittydent according to transverse strength shown a significant difference in heat cure and self cure (p=0.030), there is no significant differences between heat cure and thermoplastic resin and a significant difference between self cure and thermoplastic resin [P=0.004]. (Table 4)

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The materials treated with correga shown no significant difference heat cure and self cure, there is significant differences between heat cure and thermoplastic resin($p < 0.001$) and a significant difference between self cure and thermoplastic resin ($p= 0.048$) (Table 5).

Finally, the studied materials treated with chlorhexidine shown no significant difference heat cure and self cure, there is significant differences between heat cure and thermoplastic resin ($p= 0.008$) and there is no significant difference between self cure and thermoplastic resin (Table 6)

TABLE (1): Comparison between the different chemicals with heat cure acrylic resin material according to transverse strength

Heat cure acrylic resin	**Fitty Dent (n= 4)**	**Correga (n= 4)**	**Chlorhexidine (n= 4)**	**Control (n= 4)**	**F**	**p**
Min. – Max.	58.96 – 84.08	103.4 – 148.66	126.2 – 163.02	65.36 – 173.47		
Mean ± SD.	72.81 ± 11.60	128.58 ± 18.85	146.91 ± 18.68	125.39 ± 44.95	5.679*	0.012*
Median	74.10	131.12	149.21	131.37		
$p_{Control}$	0.069	0.998	0.674			

***F,p: F and p values for* ANOVA test*, Sig. bet. grps was done using* Post Hoc Test (Tukey)**
$p_{Fitty\ Dent}$: p value for comparing between Control group and each other group
****: Statistically significant at $p \leq 0.05$***

TABLE (2): Comparison between the different chemicals with self-cure acrylic resin according to transverse strength

Self-cure acrylic resin	**Fitty Dent (n= 4)**	**Correga (n= 4)**	**Chlorhexidine (n= 4)**	**Control (n= 4)**	**F**	**p**
Min. – Max.	74.8 – 120.7	81.9 – 152.10	85.8 – 149.7	29.91 – 95.78		
Mean ± SD.	100.18 ± 22.43	109.65 ± 34.22	116.95 ± 32.66	68.19 ± 28.86	2.068	0.158
Median	102.60	102.30	116.15	73.54		

F,p: F and p values for ANOVA test

TABLE (3): Comparison between the different chemicals with thermoplastic resin according to transverse strength

Thermoplastic resin	**Fitty Dent (n= 4)**	**Correga (n= 4)**	**Chlorhexidine (n= 4)**	**Control (n= 4)**	**F**	**p**
Min. – Max.	51.4 – 65.3	47.2 – 92.9	60.5 – 113.8	39.4 – 68.01		
Mean ± SD.	60.18 ± 6.39	68.65 ± 20.10	86.95 ± 21.77	51.07 ± 12.26	3.496*	0.050*
Median	62.0	67.25	86.75	48.44		
$p_{Control}$	0.859	0.882	0.040*			

F,p: F and p values for ANOVA test, Sig. bet. grps was done using Post Hoc Test (Tukey)
pControl: p value for comparing between Control group and each other group
****: Statistically significant at $p \leq 0.05$***

TABLE(4): Comparison between the studied materials treated with fitty dent according to transverse strength

Fitty Dent	Heat cure acrylic resin (n= 4)	Self-cure acrylic resin (n= 4)	Thermoplastic resin (n= 4)	F	p
Min. – Max.	58.96 – 84.08	74.8 – 120.7	51.4 – 65.3	7.395*	0.013*
Mean ± SD.	72.81 ± 11.60	100.18 ± 22.43	60.18 ± 6.39		
Median	74.10	102.60	62.0		
Sig. bet. groups	p_1= 0.030*, p_2= 0.265, p_3= 0.004*				

F,p: F and p values for ANOVA test, Sig. bet. grps was done using Post Hoc Test (LSD)
p1: p value for comparing between Heat cure acrylic resin and Self-cure acrylic resin
p2: p value for comparing between Heat cure acrylic resin and Thermoplastic resin
p3: p value for comparing between Self-cure acrylic resin and Thermoplastic resin
****: Statistically significant at p ≤ 0.05***

TABLE (5): Comparison between the studied materials treated with Corega according to transverse strength

Correga	Heat cure acrylic resin (n= 4)	Self-cure acrylic resin (n= 4)	Thermoplastic resin (n= 4)	F	p
Min. – Max.	103.4 – 148.66	81.9 – 152.10	47.2 – 92.9	5.834*	0.024*
Mean ± SD.	128.58 ± 18.85	109.65 ± 34.22	68.65 ± 20.10		
Median	131.12	102.30	67.25		
Sig. bet. groups	p_1= 0.319, p_2 <0.001*, p_3= 0.048*				

***p: F and p values for* ANOVA test*, Sig. bet. grps was done using* Post Hoc Test (LSD)**
p_1: p value for comparing between Heat cure acrylic resin and Self-cure acrylic resin
p_2: p value for comparing between Heat cure acrylic resin and Thermoplastic resin
p_3: p value for comparing between Self-cure acrylic resin and Thermoplastic resin
****: Statistically significant at p ≤ 0.05***

TABLE (6): Comparison between the studied materials treated with chlorhexidine according to transverse strength

Chlorhexidi--ne	Heat cure acrylic resin (n= 4)	Self-cure acrylic resin (n= 4)	Thermopla -stic resin (n= 4)	F	p
Min. – Max.	126.2 – 163.02	85.8 – 149.7	60.5 – 113.8	5.708*	0.025*
Mean ± SD.	146.91 ± 18.68	116.95 ± 32.66	86.95 ± 21.77		
Median	149.21	116.15	86.75		
Sig. bet. groups	p_1= 0.126, p_2= 0.008*, p_3= 0.125				

***F,p: F and p values for* ANOVA test*, Sig. bet. grps was done using* Post Hoc Test (LSD)**
p_1: p value for comparing between Heat cure acrylic resin and Self-cure acrylic resin
p_2: p value for comparing between Heat cure acrylic resin and Thermoplastic resin
p_3: p value for comparing between Self-cure acrylic resin and Thermoplastic resin
****: Statistically significant at p ≤ 0.05***

DISCUSION

Denture cleaning being an important part in maintenance of prosthesis and reducing the oral problems, needs to be performed effectively as well as routinely. In choosing a disinfectant for dental prosthesis consideration must also be given to the compatibility with the type of material to be disinfected in order to avoid adverse effects[30]. The objective of this study was to investigate the effects of three commercially available and commonly used denture cleansers(Fitty ® Dent, Corega Tabs and 2% Chlorhexidine gluconate) on the transvers strength of three different denture base materials (Heat cure acrylic resin, self cure acrylic resin and thermoplastic denture base material). The test in this study is transverse(flexural) strength which is a combination of compressive, tensile and shear strengths, all of which directly reflect the stiffness and resistance of a denture base material to fracture inside the mouth [31]. There are controversies between our results and the results of the other researches which may due to the differences in compositions, concentration and soaking time of the chemical disinfectants. The results of this study showed that heat cure acrylic resin material group has a significant differences of flexural strength between the different chemical disinfectants and control group. Chlorhexidine group was the highest flexural strength followed by corega group in comparison to control group. Pavarina et al (2003) [32]. stated that the flexural strength of the two heat cured denture base acrylic resins remained unaffected after immersion in the three disinfectants solutions for 10 minutes (4% chlorhexidine, 1% sodium hypochlorite and 3•78% sodium perborate). In accordance with those of Asad et al, (1992) [15], who found that the use of 0•5% chlorhexidine did not significantly affect the flexural strength of a denture base acrylic resin after 7-day immersion. However, they observed that a non-cross linked homopolymer resin was significantly affected when the specimens stored in alcohol-based disinfectant were compared with those stored in water for the same period. The results disagree with Peracini et al, (2010) [33], who concluded that there was significantly diminished in the flexural strength of the acrylic resin after its immersion in denture cleansers (Corega Tabs, Bony Plus), than the control group distilled water. Our study showed that heat cure acrylic resin material with fitty dent has the lowest flexural strength in comparison to the other chemical disinfectants as well as control group. Our finding are supported by Sethi et al (2017) [34], who concluded that fittydent causes more reduction in the flexural strength of heat cure denture acrylic resins followed by clinosdent and distilled water (control).This can be explained that fitty dent may have a plasticizing effect on the resin matrix, thus decreasing the strength of resin[35]. This study showed that self cure acrylic resin has no significant change for flexural strength among the different chemical disinfectants and control group, this finding supported by Morweng et al (2016) [36]. The present study showed that there was significant differences of flexural strength between the different chemical disinfectants and control group with thermoplastic resin material. Chlorhexidine group was the highest flexural strength followed by corega group and fitty dent in comparison to control group. Despite the differences in chemical denture cleansers and soaking time Salman and Saleem (2011) [37] studied the effect of two prepared denture cleansers (4% oxalic acid, 4% tartaric acid) in addition to one commercial denture cleanser (lacalut dent) 7 days period (15 minutes soaking, twice daily with 4 hours between each soak) on the flexural strength of thermoplastic denture base materials in comparison to the conventional heat cured acrylic. They concluded that the three cleansers didn't affect its flexural strength. In the present study showed that corega and chlorhexidine have high significant difference in transverse strength between heat cure acrylic group and thermoplastic group (heat cure acrylic higher than thermoplastic denture base material), but fittydent has no significant difference between them. Our finding are supported by Salman and Saleem (2011) (37) who concluded that conventional heat cured

acrylic had better indentation hardness and flexural strength than thermoplastic resin. There were an adverse effect of the prepared denture cleansers which contain isopropyl alcohol on indentation hardness and flexural strength of conventional heat cured acrylic, it decreased both those properties. Our results demonstrated that the Corega and chlorhexidine have no significant difference in transverse strength between heat cure acrylic group and self cure, but fittydent has high significant difference between them. (self cure acrylic group higher than heat cure acrylic group). These results may be explained that the two polymerized resins evaluated contain cross-linking agent, which has been used widely in the manufacture of acrylic resin to increase their resistance to solvents and surface stresses [38]. Our results finding are supported by Morweng et al (2016) [36] who concluded that the alkaline peroxide cleaner(corega) had no significant effect on the flexural strength on both heat cure acrylic group and self cure group, irrespective of duration of immersion. In the present study, Fittydent and Corega have high significant difference in transverse strength between self cure acrylic group and thermoplastic group (self cure acrylic group higher than thermoplastic) but chlorhexidin has no significant difference between them which may be due to the difference in structural formula (chemical composition) of these two type of denture base materials, and polymerization technique.

CONCLUSION

Within the limitations of the current study the following conclusions were drawn:

- Corega and chlorhexidine, used with heat cure resin showed significantly increase in transverse strength than thermoplastic resin but no significant difference between it and self cure. As well as corega used with thermoplastic resin showed significantly reduction in transverse strength than self cure but no significant difference between them by chlorhexidine.
- fittydent used with, heat cure showed highly significantly reduction in transverse strength than the other chemical cleansers as well as control group. When used with self cure showed highly significantly increase in transverse strength than the heat cure & thermoplastic resin

RECOMMENDATIONS

1. Chlorhexidine and corega are recommended for heat cure acrylic resin
2. Fitty dent is not recommended for heat cure
3. All the chemical disinfectants can be used with self cure acrylic resin , fitty dent is the best.
4. All the chemical disinfectants can be used with thermoplastic resin .
5. Further studies can be directed to assess the effect of varying concentrations and immersion periods of chemical cleansers on other relevant physical properties of denture base material , so as to help the clinician choose the best material

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