

# The Effect of Different Disinfectant Solutions on Shear Bond Strength of Acrylic Teeth to Flexible Denture Base Material

**Ihssan F Al-Takai**  
BDS, MSc (Asst. lec.)

**Department of Prosthodontic**  
College of Dentistry, University of Mosul

## الخلاصة

**الاهداف:** تحدد الدراسة الى تقييم تأثير ثلاثة محاليل كيميائية والماء المقطر على قوة الربط بين الاسنان الصناعية الاكريلية و مادة قاعدة الطقم المرنة لثلاث فترات مختلفة. **المواد و طرائق العمل:** ستون عينة حضرت لاجراء فحص قيمة قوة الربط ووزعت على اربع مجاميع بالاعتماد على انواع المحاليل الكيميائية المعقمة والماء المقطر المستخدمة في الدراسة. المحلول الاول هو الخل المخفف والثاني هو الملح اما الثالث فهو الكلوروهيكسيدين واخيرا الرابع وهو الماء المقطر. كل مجموعة قسمت الى ثلاثة مجاميع فرعية وحسب مدة التعقيم هي اسبوع واحد، شهر واحد وثلاثة اشهر وكل مجموعة فرعية فيها خمس عينات. العينة تتألف من اسنان اكريليك مربوطة الى عصية من مادة الفالبلاست الطرية الفحص اجري باستخدام جهاز قياس قوة الربط. استخدم اختبار تحليل التباين و اختبار دنكن و اختباريوست هوك. **النتائج:** اظهرت النتائج ان مجموعة الماء المقطر اظهرت اعلى النتائج لقوة الربط بينما مجموعة الخل المخفف اظهرت اقل النتائج لقوة الربط في جميع فترات الغمر. كذلك اظهرت النتائج ان هناك فرقا معنويا بين جميع مجاميع التعقيم والماء المقطر وكذلك هناك اختلاف معنوي بين جميع فترات الغمر. **الاستنتاجات:** هناك فرق معنوي بين قيم قوة الربط بين الاسنان الصناعية الاكريلية و مادة قاعدة الطقم المرنة بعد التعقيم بمحاليل التعقيم الثلاثة والماء المقطر في جميع فترات الغمر. محلول الخل المخفف له التأثير الاكبر على قوة الربط بينما الماء المقطر له التأثير الاقل في جميع فترات الغمر. قوة الربط تقل بزيادة وقت الغمر ولكن قوة الربط قلت بشكل قليل عند غمر العينات بمحلول الكلوروهيكسيدين كلما زاد وقت الغمر مقارنة مع باقي محاليل الدراسة ولجميع فترات الغمر.

## ABSTRACT

**Aims:** is to evaluate the effect of three different disinfectant solutions on shear bond strength of artificial acrylic teeth for retention to flexible denture base material at three different periods of time. **Materials and Methods:** The total number of samples was (60) divided into 4 groups according to the three chemical disinfectant solution which used and the control distilled water group: Group( I) vinegar group, Group( II) salt group , Group(III) Chlorohexidine group , Group (IV ) the control distilled water group, where each group was subdivided into three subgroups according to disinfection periods which are 1week, 1month and 3month where each group contain five samples. The samples of shear bond strength test were consist of acrylic teeth with T-shape design for retention attached to rod of valplast The test was performed using a Universal testing machine. ANOVA, Duncun's multiple range and Post Hoc Tests were carried out to determine the significant difference at  $p \leq 0.01\%$ . **Results:** The results appeared that control distilled water group has the highest value for the three periods of disinfection (1 week,1month,3months), while vinegar solution group has the least value. The results showed that there were significant differences between the four tested groups and also there were significant differences among all periods of time of disinfections. **Conclusion:** There was a significant difference of shear bond strength between artificial teeth and flexible denture base material after disinfection in the four disinfectant solutions for all periods of time of immersion. Vinegar group had highest effect on the bond strength while the distilled water group had the least effect after all periods of time of disinfections. Shear bond strength decreased with increasing the time immersion. The shear bond strength was lowest in chloherxidine group as the time of immersion increase when compared with the two other groups of disinfection solutions in this study. **Key words:** Flexible denture, shear bond.

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## INTRODUCTION

Thermoplastic materials for dental prostheses, Valplast and Flexiplast, were first introduced to dentistry in the 1950s. Both materials were similar grades of

Polyamides (nylon plastics). Valplast is a pressure injected at a temperature of 274°C-300°C. Flexible denture base resin that is ideal for partial dentures and unilateral restorations. No tooth or tissue

preparation is needed.<sup>(1-5)</sup> Flexible denture base material is a nylon based (polyamide) thermoplastic denture base material. It is flexible, nearly unbreakable, pink-coloured like gums, can be built quite thin, and can form not only the denture base, but also the clasps as well. The thermoplastic material has a unique property that it does not chemically bond with any of the acrylic resin / porcelain teeth, so mechanical bonding is the only mode to use in the polyamide denture base material. Sufficient height of the selected teeth is required for mechanical bonding. Mechanical undercuts (diatorics) should be made in the centre of each tooth so that melted fluid polyamide could flow into the undercuts so as to retain the tooth in the denture.<sup>(6-9)</sup> There are several types of RPDs, all of them use standard denture teeth as replacements for the missing natural teeth. Denture hygiene is essential to maintain the service ability of the denture because of esthetic concerns. Because of that the most effective preventive and curative treatment for pathogens is believed, denture cleansers have been studied to identify the ideal product.<sup>(10)</sup> Dentures can be cleaned mechanically, chemically or through a combination of these.<sup>(11)</sup> Chlorhexidine gluconate is a cationic oral antiseptic agent with bactericidal activity and acts by destabilizing and penetrating in bacterial cell membranes. It has been widely used due to its antiseptic and antimicrobial effects in oral and dental diseases.<sup>(12)</sup> The use of vinegar solution was effective in

killing adherent microorganisms.<sup>(13)</sup> Disinfection by resilient liner in sodium chloride solution proved a more effective method than exposure to microwave energy.<sup>(14)</sup> Aim of this study is to evaluate the effect of three different disinfectant solutions (acetic acid, NaCl and chlorhexidine) for three periods of time (1 week, 1 month and three months) on shear bond strength of artificial acrylic teeth to flexible denture base.

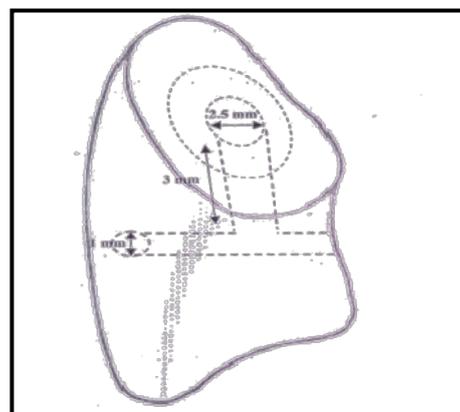
## MATERIALS AND METHODS

The sample for the shear bond strength test consist of an acrylic teeth, central incisor (Meheco, China) which prepared and attached to it a rod of Valplast (China) 5mm in radius and 2.5 cm in length<sup>(15)</sup> as shown in Figure (1).

The T mechanical designs were prepared in the center of the ridge lap surface of the acrylic teeth as shown in Figure (2). T-shape design has the highest value for increase retention means with flexible base, this can be explained in that, Valplast relies solely on mechanical retention to retain the teeth and if there is not enough room to place retention holes in the teeth, they can become displaced overtime<sup>(16)</sup>, the detachment may be attributed to lesser ridge lap surface area available for bonding and direction of stress encountered during function.<sup>(17)</sup> This design is prepared as T- shape (diatorics) with dimension 2.5mm, 3mm (width, depth respectively) with lateral extension 1mm in width as shown in Figure (2). The



**Figure (1):** Sample of tooth for shearbond preparation were made using carbide fissure bur. After that 5mm end of the wax



**Figure (2):** Mechanical retention means T-shape pattern was placed on the ridge lap surface of the acrylic teeth. Then the combination

of the acrylic tooth and the wax pattern was placed in denture flask to substitute the wax with Valplast and curing occurred with injected technique. Curing occurred with using chemical bonding agent (methyl methacrylate monomer). Monomer dissolves the tooth surface and forms a durable secondary semi-interpenetrating polymer networks (IPN) structure.<sup>(18-20)</sup> A drop of monomer was applied with a small brush on the denture tooth surface for waiting time 60 seconds before packing. All specimens were stored at 37°C for 2 hours in distilled water

before shear bond strength test has been performed. The total number of samples was (60) divided into 4 groups according to the three chemical disinfectant solution which used and the control distilled water group as shown in Table(1): Group(I) vinegar group, Group( II) salt group , Group(III) Chlorohexidinegroup , Group (IV ) the control distilled water group, where each group subdivided into three groups contained five samples and all these groups were disinfected at three time periods which are 1week, 1month and 3months.

**Table (1):** The Chemical Compounds, Concentrations used in the Study

No.	Type	Product	Conc.%	Manufacture
1	Dania (acetic acid)	Artificial clear vinegar	5	Jordan
2	Sodium chloride (without iodine)	Salt	40%	Iraq
3	Chlorohexidine gluconate	Chlorohexidinegluconate		Iraq
4	Distilled water	Distilled water		Iraq

*Disinfection Procedures:*

The disinfection method was as follow:

1. The samples of distilled water group were soaked for 1week, 1month and 3 months in distilled water only for 8 hours per day at 37°C by using a clock timer then the samples were left dry.
2. The samples of saturated salt group were soaked for half an hour per day in saturated salt solution for 1week, 1month and 3 months then the samples were left dry.
3. The samples of Vinegar group were soaked for half an hour per day in vinegar solution for 1week, 1month and 3 months then the samples were left dry.
4. The samples of CHX group were soaked for half an hour per day in CHX solution

for 1week, 1month and 3 months then the samples were left dry.

All samples soaked in three different disinfectant solutions( acetic acid, NaCl and chlorohexidine ) half hour per day for three periods of time (1 week, 1month and three months). The testing performed on a Universal testing machine (Instron) and the samples were held by using the device holder (clamp) as shown in Figure (3) .The load at fracture was recorded.<sup>(9)</sup> Statistically mean and standard deviation were calculated. ANOVA, Duncan's multiple range test and Post Hoc Tests were carried out to determine the significant differences among tested groups at  $p \leq 0.01$ .



**Figure (3):** Universal testing machine(Instron)

**RESULTS**

The most common clinical problem between the artificial teeth and denture base resin are bond failures at the interfacial region.<sup>(21)</sup> Many factors can influence this bonding which includes chemical and mechanical preparation on ridge lap surface of tooth, the presence of impurities along tooth/ denture base

interface due to poor laboratory techniques.<sup>(22)</sup> The results in Table (2) appeared that Group (VI) control distilled water had the highest value for the three periods of disinfection (7, 30,90 days) (14.464 MPa, 14.162 MPa, 13.711 MPa respectively), while Group(I) vinegar solution had the least value (12.376MPa, 12.1182 MPa, 11.4268 MPa respectively).

**Table (2):** Mean and standard deviation of shear bond strength between artificial acrylic teeth and Valplast denture base materials for four tested chemical disinfectant solutions for three periods of times

Time	Solutions	No	Mean (MPa)	SD
1week	salt	5	12.656	0.2006
	Vinegar	5	12.376	0.1238
	Chx	5	13.548	0.561
	Distilled water	5	14.464	0.4759
1month	salt	5	12.3770	0.2109
	Vinegar	5	12.1182	0.348227
	Chx	5	13.222	0.17444
	Distilled water	5	14.162	0.2856
3month	salt	5	12.0046	0.13802
	Vinegar	5	11.4268	0.12421
	Chx	5	12.9640	0.2729
	Distilled water	5	13.7110	0.457963

No: number of samples SD: standard deviation

The results of ANOVA test and Post Hoc Tests in Tables (3, 4, 5) showed that there is a significant difference of shear

bond strength between three disinfectant solutions and the distilled water group among all periods of disinfections time.

**Table (3):** ANOVA of shear bond strength between artificial acrylic teeth and Valplast denture base materials between four tested chemical disinfectant solutions for three periods of times

Time	Source of variance	Sum of square	DF	Mean square	F-value	**P value
1 week	Between groups	13.399	3	4.466	29.93	0.000
	Within groups	2.388	16	0.149		
	Total	15.787	19	4.269		
1month	Between groups	12.808	16	0.069	61.477	0.000
	Within groups	1.111	19	5.127		
	Total	13.919	3			
3month	Between groups	15.381	3	0.080	64.351	0.000
	Within groups	1.275	16			
	Total	16.656	19			

DF : degree of freedom , P\*\* : Means are highly statistically significant different at  $p \leq 0.01$

**Table (4):** Post Hoc Tests of shear bond strength between artificial acrylic teeth and Valplast denture base materials for four tested disinfectant solutions for three periods of times

Time	(i)solution	(J)solution	Mean differences (i-j)	SE	**p-value
1week	Salt	Distilled water	-1.8084	0.244215	0.000**
	Vinegar	Distilled water	-2.0884	0.244215	0.000**
	Chx	Distilled water	-0.9164	0.244215	0.005**
1month	Salt	Distilled water	-1.785	0.1666	0.000**
	Vinegar	Distilled water	-2.0438	0.1666	0.000**
	Chx	Distilled water	-0.9400	0.1666	0.000**
3month	Salt	Distilled water	-1.7064	0.17851	0.000**
	Vinegar	Distilled water	-2.2842	0.17851	0.000**
	Chx	Distilled water	-0.7470	0.17851	0.002**

No: number of samples, \*\*Means with different letters are highly statistically significant different at  $p \leq 0.01\%$

**Table (5):** ANOVA of shear bond strength between artificial acrylic teeth and Valplast denture base materials for four tested disinfectant solutions among three periods of times.

Solution	Source of variance	Sum of square	DF	Mean square	F-value	*P value
Salt	Between groups	1.068	2	0.534	15.433	0.000**
	Within groups	0.415	12	0.035		
	Total	1.483	14			
Vinegar	Between groups	2.409	2	1.205	23.771	0.000**
	Within groups	0.608	12	0.051		
	Total	3.017	14			
Chx	Between groups	0.856	2	0.428	3.061	0.044*
	Within groups	1.679	12	0.140		
	Total	2.535	14			
Distilled water	Between groups	1.437	2	0.719	4.164	0.042*
	Within groups	2.071	12	0.173		
	Total	3.509	14			

DF : degree of freedom , P\*: Means are highly statistically significant different at  $p \leq 0.05$

\*\* $p \leq 0.01$  , \*  $p \leq 0.05$

The results of Duncan multiple range test in Table (6) for salt group appeared that there is a significant differences among all periods of time of disinfections, while in Table (7) for vinegar group the results appeared that there is a significant difference between 3 months with 1 month

and 1 week of disinfections, in Table (8) for Chx group the results appeared that there is a significant differences between 3 months and 1 week of disinfections, while in Table (9) for distilled water group the results appeared that there is a significant differences between 3 months and 1 week

of disinfections.

**Table (6) :** Duncan's multiple range test for salt solution

Time	No	Subset for alpha=0.05		
		A	B	C
3 months	5	12.005		
1 month	5		12.3770	
1 week	5			12.656

**Table (7) :** Duncan's multiple range test for vinegar solution

Time	No	Subset for alpha=0.05	
		A	B
3 months	5	11.4268	
1 month	5		12.1182
1 week	5		12.376

**Table (8):** Duncan's multiple range test for CHX solution

Time	No	Subset for alpha=0.05	
		A	B
3 months	5	12.964	
1 month	5	13.222	13.222
1 week	5		13.548

**Table (9) :** Duncan's multiple range test for Distilled Water

Time	No	Subset for alpha=0.05	
		A	B
3 months	5	13.711	
1 month	5	14.162	14.1620
1 week	5		14.4644

There are no previous studies to relate the result of this study to them. This result could be explained in that possible factors that influence solubility includes immersion time, concentration of solute in dissolution medium.<sup>(23)</sup> also the high water sorption and solubility of materials decrease mechanical properties such as hardness, bond strength and fatigue limit.<sup>(24)</sup> The lower value which was achieved with vinegar solution can be explained in that the clear vinegar is

considered as acidic solvent leads to the softening of the surface layer of the material and decreases interchain forces and this will allow the water molecules to penetrate the material so, this factor will affect on the shear strength of the polymer, in addition the high acidity of the solution leads to an increase in water sorption and this in turn leads to an increase the plasticizing effect of the penetrated water molecules.<sup>(25)</sup> The value which was achieved with salt group can be explained

in that the saturated salt solution can lead to plasticization, which results in disentanglement, crazing and embrittlement of the polymers, which is a reflection of its interaction with the polymer and leads to decrease the shear bond and tensile strength. These behaviors likely reflect the degree of interaction between the salts and the polymer, which again is a function of two forces. These forces are the plasticization of polymer by water, the complexation of salt with the polymer chain (the interference of hydrogen bond) and the degradation of the polymer with treatment. This reflected the amount of moisture absorbed by the samples.<sup>(26)</sup> Other explanation is that the osmotic pressure created by Na<sup>+</sup> and Cl<sup>-</sup> ions will affect the leaching out of the polymer, in addition to that during disinfection, one or more environmental stress factors act on the bulk polymer. The effects of these stress factors are translated to the microscopic/molecular level where changes occur in the polymer network or chain.<sup>(27)</sup> Yassin,<sup>(28)</sup> concluded that the flexible material when left in distilled water has decreased in the bond strength of the material. The decrease in shear bond strength was lowest value in chlorhexidine group as the time of immersion increase when compared with other groups of disinfection in this study. This was in agreement with Naik (2005)<sup>(29)</sup> and this may be due to that that highest molecular weight and the highest viscosity of the chlorhexidine incomparable to that of distilled water solution and this may decrease the absorption of chlorhexidine through the acrylic /flexible interface and this will lead to lowering the effect of chlorhexidine solution on the shear bond strength in compared to control distilled water solution, this could explain the highest value of tensile and shear strength and dimensional accuracy after that of control group as compared with that of experimental groups of CHX which show obvious change in these properties.<sup>(30)</sup>

### CONCLUSION

There is a significant difference of shear bond strength between artificial teeth and flexible denture base material after disinfection in the four disinfectant

solutions after all periods of time of immersion. Vinegar solution has highest effect on the bond strength while the distilled water solution has the least effect after all periods of time of disinfections. The shear bond strength was lowest in chlorhexidine group as the time of immersion increase when compared with other two groups of disinfection in this study.

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