



Effect of surface treatment on shear bond strength of artificial teeth to the denture base

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Abstract

Fracture or debonding of plastic teeth from the denture base are common clinical problems, the optimal combination of acrylic resin denture teeth and microwave cured denture base resin is not well known. One hundred and twenty teeth (florident, acrylic teeth cross-linked, china) were prepared and cured by heat cured (AkrilEks, heat-curing resin for denture powder liquid, GuLSA LTD. Izmir-Turkey), and microwave cured (Acron mc, microwave-curing denture base resin powder liquid, GCLAB Technologies inc. Alsip, IL60803 Japan) acrylic resin were used, then the teeth were divided into six groups and treated with different surface treatment, the first group received no further treatment (control); the second group treatment with diatoric preparation; the third group treated with thinner (Turpentine-DYNA CoAT, Thinner, Netherlands); the fourth group treated with tone (Propanone, Acetone, England 99% Purity-Analyer); the fifth group were diatoric conditioned with acetone; the sixth group were diatoric conditioned with thinner; (2nd group, 5th group and 6th group had been a cutting mesiodistal retention grooves 2mm deep and 3mm wide acute into ridge lap in acrylic resin teeth. One hundred and twenty specimens were divided into two groups, first one was processed by conventional method and the other one processed by microwave method and then tested by instron universal testing machine (instron corporation 1195, canton mass). The results showed that microwave-cured resin has a significant lower shear bond strength (SBS) mean values than water bath-cured resin to all denture teeth types. All surface treatment application improved the (SBS) significantly level at (p value < 0.05), while the sixth group (diatoric conditioned with thinner) showed the highest (SBS) than other group. The types of acrylic denture resin, surface treatment and curing technique influenced the shear bond strength of the tooth to the base the results of this study influenced the shear bond strength of the tooth to the base. The results of this study indicate that diatoric condition with thinner may be recommended to be applied on the denture ridge lap prior to denture base processing.

Keyword: hot cure acrylic, microwave acrylic, thinner, Acetone, retentive groove, shear bond strength.

Introduction

The shear strength is the maximum stress that a material can withstand before failure in a shear mode of loading, it is particularly important in

the study of interfaces between two materials.⁽¹⁾

(poly methyl methacrylate) is the most commonly material used in

construction of denture base since 1930⁽²⁾. The polymerization of this resin is an additional reaction that required the activation of the monomer to polymer, heat which is usually supplied by using a hot water- bath or microwave⁽³⁾. The failure rate of acrylic resin denture due to fractures have been reported to be an acceptably high⁽⁴⁾. And the most common type of failure encountered was debonding fracture of the teeth. The lack of adequate bonding is believed to be result of incompatibility surface conditions at the tooth-base interface. This incompatibility is brought by two factors:

1. Contamination of the surface. Particularly by wax and possibly by sodium alginate mould seal. As a separating medium.
2. The difference in the structure of the two components due to their difference processing routes⁽⁵⁾.

Aim of study: This study carried out to compare the shear bond strength of artificial teeth and denture base cured by water- bath and microware after application of different surface treatments.

Material and Methods

1. Grouping the specimens:

One hundred and twenty specimens were prepared from denture base material and from the same version of artificial teeth these specimens were divided into 6 group as the Following:

1. First group: teeth without any surface treatment(control).
2. Second group: teeth conditioned with diatoric preparation(retention groove).
3. Third group: teeth conditioned with thinner without groove.
4. Fourth group: teeth conditioned with acetone without groove.

5. Fifth group: teeth with retention groove conditioned with acetone.

6. Sixth group: teeth with retention groove conditioned with thinner.

Specimens of each group divided into two groups , group 1 processed by water bath and the group 2 processed by microwave method

2. Preparation of specimens:

A. Preparation of teeth:

One hundred and twenty acrylic central incisors (right and left) they were from same mould with regard to shape and size, all(120)teeth were cut at the neck (gingival portion) and, as follow:

The retention groove was prepared by using are inverted cone carbide bur, which produces a groove 2mm deep, 3mm wide of the bottom, the groove extended for a distance of $5\text{mm} \pm 0.5\text{mm}$ mesio, distally, for the second, fifth and sixth group⁽⁶⁾. N0.O brush used for paint the surface with (acetone, thinner) at room temperature for 180 seconds, For the third, fourth and sixth groups⁽⁷⁾. for standardization dropper used to take one drop for application for each solution .

B. Mould preparation :

Metal mould made from a brass contained rectangular hollow the dimensions of this hollow are (17mm, 7mm, 9mm and 3mm), with a 3mm diameter hollow in⁽⁸⁾. figure(1) .

The wax melt in small stainless steel container and poured the molten wax inside the metal mould then the teeth was waxed on the beveled surface a rectangular wax Block, at a 45 degree from the base of the wax block and measured by varnier. Figure(2) .

C. Flasking :

The convention flasking technique for complete denture was used .

D. Packing :

The acrylic resin was packed in the late dough stage indicated by the clean separation of the resin from the walls of glass mixing jar for (AkrilEks). The resin took 15min to reach the dough stage while for (acron mc). It took 20min to reach the stage.

The teeth samples were treated with (acetone, thinner), for 180 seconds embedded in the mould then acrylic resin dough was placed and the two halves were assembled and placed under the press with gradual application of pressure to allow oven flow of the dough throughout the mould space .

E. Curing cycle :

Acron mc: as recommended by manufacturer, cured with microwave irradiation for 3min at 500 watts. Then placed in cold water for 20min⁽⁹⁾ .

F. Finishing and polishing :

All of the samples were carefully de-flasked and cleared and polishing was done. Before testing all specimens were stored in distilled water (37C^o) for (10) days⁽⁸⁾. Figure (3) .

3. Shear bond strength (SBS) :

After storage the acrylic resin block were held in fixture, and the test holder oriented in such a manner that the cross head applied a force parallel to bonding surface of the acrylic resin denture teeth specimens were loaded until the fracture and load of fracture was recorded from the instron graph reader in Newton⁽¹⁰⁾ . The shear bond strength was calculated based on the (F) in (N) at fracture, and adhesive surface area (S) in (mm²) and converted to (mpa.) B.S.=f/s.⁽¹¹⁾

Results

The shear bond strength of the artificial acrylic teeth to water-bath and microwave acrylic base resin was tested and the results of the test performed are divided as follows :

t-test difference between the teeth and acrylic denture base resin cured by microwave and water bath curing techniques as influenced by each surface treatment .

Group (1) the teeth received no further treatment (control). The result have shown that highest (SBS) mean value were obtained in water-bath curing technique (10.782mpa), while the lowest (SBS) mean value were obtained in microwave curing technique (10.470mpa) t-test shown that there was a non-significant difference at (p>0.05) group (2) the teeth conditioned by (retentive groove).The results have shown that the highest(SBS)value was obtained in water- bath curing(11.352 mpa) while the lowest(SBS) value were obtained in microwave curing technique(10.087 mpa).

T-test shown that there was a high significant difference at (p<0.001) in favor water- bath over the microwave curing technique. Group(3) the teeth conditional with(thinner) the results have shown that the highest(SBS) mean value were obtained in water-bath curing technique(11.923 mpa) while the lowest(SBS) mean value were obtained in microwave curing technique(11.923 mpa).while the lowest (SBS)mean value were obtained in microwave curing technique(10.983 mpa).

T-test shown that there was a significant difference at (p<0.5/05) in favour water-bath over the microwave(urine) technique. Group(4) the teeth conditioned with (acetone) the result have shown that the highest(SBS)mean value were obtained in water-bath curing technique(10.680 mpa). While the lowest(SBS)mean

value were obtained in microwave curing technique (9.919 mpa).

T-test shown that there was a significant difference at ($p < 0.05$) in favor water- bath over the microwave curing technique. Group (5) the teeth conditioned by (retentive groove with acetone), the result have shown that the highest (SBS) mean value were obtained in water- bath curing technique (11.801 mpa), while the lowest (SBS) mean value were obtained in microwave curing technique (10.999 mpa).

T-test shown that there was a significant difference at ($p < 0.05$) in favor water- bath over the microwave curing technique table (1). Group (6) the teeth highest (SBS) mean value were obtained in water- bath curing technique (13.676 mpa), while the lowest (SBS) mean value were obtained in microwave curing technique (12.061 mpa). T-test shown that there was a high significant difference at ($p < 0.001$) in favor water-bath over the microwave curing technique table (1).

Discussion

1. The effect of curing technique :

The microwave cured resin groups exhibited lower shear bond strength than water-bath cured resin indication that this type of acrylic resin and method of polymerization influence tooth-to base bond strength this is agreement with finding to takahoshi et al (2000), and Schneider et al (2002) who suggested that the nature of microwave cured acrylic resin resulted in less interpenetration of the tooth and denture base polymer network, more over the polymerized base material was in contact with the tooth surface for significantly less time with the microwave procedure than that with the conventional water-bath one there may due to be less swelling which

leads to less interpenetrating and thus decreasing the bond strength.

2. The effect of surface treatment :

A. Diatoric (retention groove) placement :

The groups conditioned with retention groove showed high significant increase in the (SBS) mean value at (P value < 0.001). Caradosh et al (1990) and Takohashi et al (2000), suggested the benefit of using a diatoric may be explained by two mechanism, first the diatoric increases the surface area on the denture teeth available for the polymerizing denture base resin to interact with. Second, the diatoric of denture base resin embedded in the denture tooth creates a path of resistance to fracture in a direction different from the denture tooth denture base resin interface .

B. Thinner wetting :

Thinner wetting:

Thinner improved the (SBS) significantly at (p -value < 0.05) in all treated teeth. The application of thinner which is a strong solvent since it is composed from multisolvents could dissolve the polymer more than acetone as evidence that the solvents had facilitated the diffusion of the polymerization monomer from the denture base and improve the formation of a more extensive interwoven polymer network.⁽¹²⁾

C. Acetone wetting:

The results showed a significant improved at (p -value < 0.05) in groups treated with acetone for both curing technique the acetone is a powerful solvent for (PMMA) wetting the surface with acetone would wash away most of microdebries and smooth out the adhesive and create sponge like structure.

D. Acetone wetting with (retention groove): The result showed a significant improve at (p-value <0.05) in (SBS)in groups groove treated with acetone. The acetone is a powerful solvent for (pmma) wetting the surface with acetone would wash away most of microdebries and smooth out the adhesive surface and create a sponge like structure. In addition to the activity of diatoric preparation which increase the surface area on the artificial teeth available for the polymerizing with the denture base resin .⁽¹³⁾

E. Thinner wetting with (retention groove): The group groove with thinner wetting improved the (SBS) highly significantly at(p-value <0.001) in all groove with thinner treated teeth. The application of thinner to the prepared teeth with groove could dissolve the polymer in addition to the activity of diatoric preparation which increase the surface area on the denture teeth available for the polymerizing denture base resin to interact with.⁽¹³⁾

Conclusion

Under the present experimental conditions, the following conclusions can be drawn:

- 1.Over all high bond strength to the denture tooth tested was obtained with the conventional heat polymerized acrylic resin rather than the microwave polymerized acrylic resin.
- 2.The bond between the denture teeth and denture base resin was improved by the vertical retention grooves cut in the ridge lap surface of the teeth which increase retention to acrylic resin denture base.

3.Groove with thinner produced the higher shear bond strength to denture teeth in bath curing method(microwave and conventional).

4.Acetone treated teeth surface improved the shear bond strength but less significant than thinner.

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Table(1): t-test between water Bath and Micro wave

Groups	Mean (Mpa) Water bath	Mean (Mpa) Micro wave	Difference between two means	t-test	p-value	sig
control	10.782	10.47	0.312	1.20	0.25	(*) NS
Groove	11.352	10.087	1.265	5.36	0.000	(**) HS
Thinner	11.923	10.983	0.94	3.38	0.0038	(***) S
Acetone	10.68	9.919	0.761	2.66	0.017	S
Groove+Acetone	11.801	10.999	0.802	2.51	0.023	S
Groove+Thinner	13.676	12.061	1.615	5.46	0.000	HS

(*)Non significant at (p> 0.05) (**)High significant at(p<0.001) (***)Significant at(p<0.05)

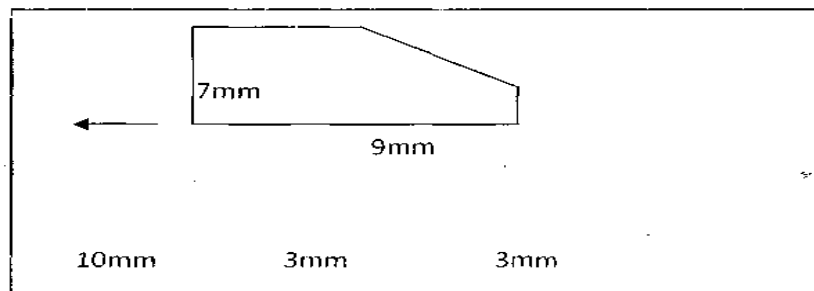


Figure (1): Metal mould for a rectangular wax block.

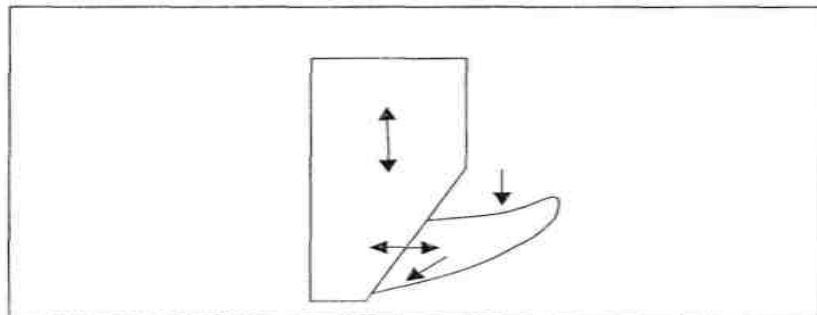


Figure (2): Alignment of tooth on the beveled surface.

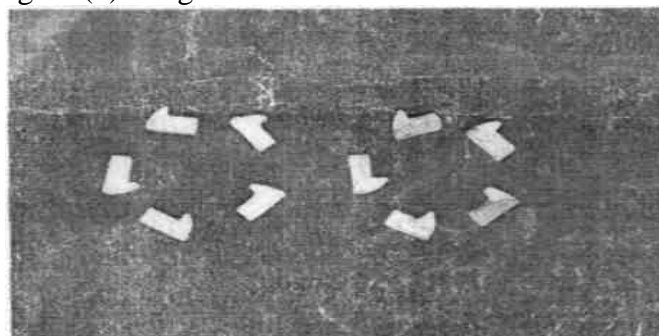


Figure (3): Specimens after finishing and polishing, ready for testing, (left group microwave cured resin sample and the right group water bath cured resin samples)