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Evaluation of the tensile strength of heat –cured acrylic resin reinforced by stainless steel wire (A comparative study)

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Abstract

The fracture of acrylic resin denture base was a popular problem in the prosthodontic work.

In the present study (20) specimens were prepared and divided into (2) groups (10) specimens for heat-cure acrylic resin denture base with out stainless steel wire as a control group, others (10) specimens for heat-cure acrylic with stainless steel wire. Then we examined the tensile strength for each specimen.

From the results obtained, the tensile strength for specimens with metal wire was high significant differences when compared with the specimens with out stainless wire.

الخلاصة

أن المشكلة الشائعة في صناعة الأسنان هو الكسر الذي يحصل في قاعدة الطقم الأكريلي.

في هذه الدراسة الحالية, تم أخذ (20) عينة حضرت وقسمت إلى مجموعتين (10) عينات من الأكريلك الراتنجي الحار وبدون إضافة السلك المعدني المقاوم للصدأ و (10) عينات من الأكريلك الراتنجي الحار بإضافة السلك المعدني المقاوم للصدأ. ثم تم فحص قوة الشد التوتري لكل عينة.

من خلال النتائج التي تم الحصول عليها وجد أن قوة الشد التوتري في الأكريلك الحار وبإضافة السلك المعدني المقاوم للصدأ أعلى إحصائيا من قوة الشد التوتري في الأكريلك الحار مقارنة مع الأكريلك الحار بدون إضافة السلك المعدني المقاوم للصدأ.

Introduction

Heat polymerizing acrylic has been the most common denture base material for more than (60) year, however the mechanical strength of acrylic resin is not sufficient to maintain longevity of dentures.

Denture base acrylic resin is subjected to many different types of stress, intra orally, repeated masticatory force leads to fatigue phenomena. As a consequence fracture of the denture base can be result **(1)**.

The ultimate goal of repairing a denture to restore its original strength avoid further fracture**(2)**.

Several materials have been used to repair fractured acrylic denture including auto-polymerized acrylic resin **(3,4,5),**and heat polymerized acrylic resin. **(6,7,8,9).**

Although various methods have been proposed for repairing fractured denture base the use of auto-polymerizing acrylic resin which generally allows for a simple and quick repairs .The popular reasons for this unfavorable phenomenon is the sufficient strength of auto-polymerizing acrylic resin which lower than that of heat polymerizing acrylic resin. Therefore various methods for enhancing the strength of the repaired part have been report by reinforcement the broken acrylic denture by metal.

The purpose of this study is to find the best and strongest method for repairing fracture acrylic denture base and evaluate the tensile strength for the both two groups repaired with and without stainless steel wire reinforced.

Materials and methods

A- Metal pattern:

To same time stainless plate with dimensions of (65mm ×12.5mm×2.5±0.03mm) length , width, thickness respectively according to were constructed for tensile strength test **(10)**.

B-Mould preparation:

The metal pattern was included in metal flask was completely filled with type III dental stone (Elite model, Italy) whose surface was flattened with 320 and 400µm silicon carbide paper discs (Germany) after the setting reaction. The patterns were positioned on the stone surfaces additional dental stone filled the upper half of flask which was opened after complete setting under compression (0.5 tan), and the metal mold remover, inspecting the cavities for integrity.

The mold was washed with water and neutral detergent, and coated with separating medium.

In this study pink heat cured acrylic resin (Triplex hot Ivoclar vivadent, Liechtenstein) was used to fabricate the samples, following the manufacture's instructions of powder/ Liquid ratio by volume. Heat- cured acrylic were mixed (3.1) by volume, and than left to reach the dough phase at room temperature (approximately 23°C). after filling the mold with the dough, the flasks were fitted and pressed together in a hydraulic press for 5 minutes before polymerization process.

Curing was carried by placing the flask in a water bath and processed by heating at 74°C for about (1.30)hr, the temperature was than increased to 100°C for (30minutes)**(11)**, and then the flask was allowed to cool slowly at room temperature for (30) minutes followed by complete cooling of the flask with tap water for (15) minutes before deflasking . The acrylic patterns were then removed from the mold. (as shown in figure 1).

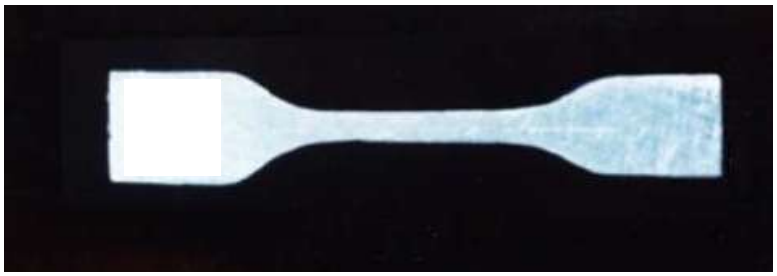

Figure (1): -Metal pattern for tensile bond strength.

All the samples were hand finishing using progressively fine grades of the silicone carbide paper (Grandees 120 to 500) with continues water cooling unless other wise stated, all the measurements were done using the starlet micrometer vernier.

Polishing was accomplish by using the rag wheel and dental pumice by a dental lathe.

C- Prepare the specimens for repair:

Cut the acrylic specimens in middle (center of the specimens) by hard metal disk bur and repaired them in a procedure similar to that repaired base plate of complete and partial denture base.

The periphery surface in both side of the fracture surface were reduced and scratch on both parts about (2±1)mm for each side by using acrylic burs and prepared stainless steel wire (0.7mm) as a zag zag shape by using three head plier (each piece of wire about (10)mm length) and we should put the wire clasp that made it between the two fractured pieces of acrylic in their position in the flask mold to maintain its dimension correctly.

Painted the halves of flask by separating medium and mixed enough amount of heat-cure acrylic resin as we do before and when the acrylic reach the dough stage. Close the upper half on the lower half and put them under compress and transfer it to the clamp. Make curing to them as in the first stage and them open the flask. Checked the two pieces become joint together and appear like one piece.

The wire becomes embedded inside the acrylic specimens. Finishing and polishing the specimen so they become ready to test the tensile bond strength.

In order to avoid excessive temperature rise which many result in specimens distortion, large amount of water was used in this polishing operation, the specimens were them polished with silicon carbide grit papers starting with grade 120 and ending with grade 500.

A master acrylic plates measuring (65mm×12.5mm×2.5±0.03mm) length, width, thickness for each specimens were prepared **.**

D-Tensile bond strength test (equipment and procedure)

An instron testing machine was used to measured the tensile bond strength of samples (figure2) induced force that resists the elongation of a material in a direction parallel to the direction of the stress **(12).**

The dumbbell-shaped specimens were conditioned at (37°C) for (48) hours **(13)** then tested using instron machine with grips suitable for holding the test specimens at a cross head speed of (0.5mm/min) with a chart speed (20mm/min) the load was measured by a tensile load cell with a maximum load of (100kg).

Specimens were loaded until fracture and the load of fracture was recorded from the instron graph reader in Kilograms (kg) which were converted in to Newton (N.) **(14).**

The value of tensile strength was calculated by the followed formula:

$$T.S = \frac{F}{A}$$

T.S= Tensile strength (N/mm^2)

F= Force at failure (N)

A= Area of across section at failure (mm)

Figure (2): Specimen under tensile bond strength test.

E- Statistical analysis

Tensile strength (N/mm^2) data were analyzed by student test (T. test).

Tests were performed at a confidence level of 95%. **(15)**

Result

Mean values, standard deviation (SD) and standard error (SE) are presented in table (1) and figure (3) for tensile strength test.

The values of tensile strength varied according to adding of metal wire. The highest mean tensile strength values was obtained in heat-cure acrylic resin denture base with metal wire (81.2710)N/mm^2, while the lowest mean tensile strength values was obtained in heat-cure acrylic resin denture base without metal wire (control group) (78.4780) N/mm^2.

Table (1): Mean, standard deviation and standard error for tensile strength of heat-cure acrylic resin denture base as influenced by metal wire.

Groups	N	Mean	Std. Deviation	Std. error	Min	Mix	t-test (p-values)	Sig.
Heat-cure acrylic without metal wire (control group)	1.0	78.4780	1.9431	0.6145	76.38	81.65	0.14	S
Heat-cure acrylic with metal wire	1.0	81.2710	2.6071	0.8244	77.38	85.46		

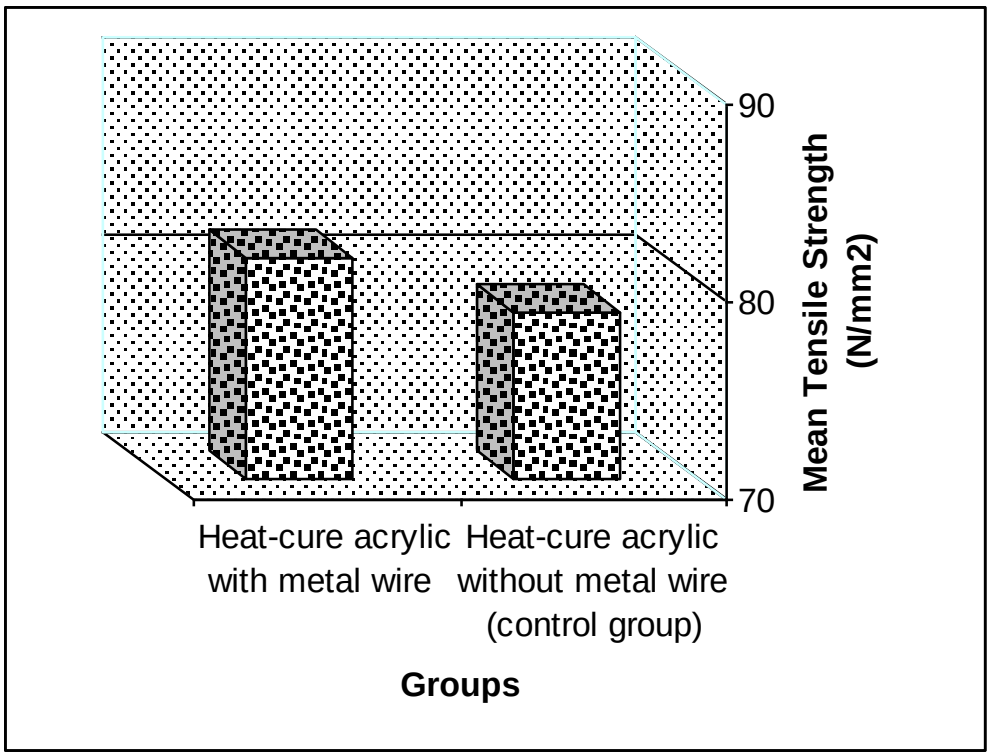

Figure3: Bar chart show the mean values for tensile strength (N/mm^2) of heat-cure acrylic resin denture base as influenced by metal wire.

T. test result for tensile bond strength showed that significant difference at ($p<0.05$) between specimens made from heat-cure acrylic resin without metal wire.

Discussion

The result of the present study showed that the tensile strength reveled significant difference among the tested groups and showed that the specimens of heat-cure acrylic resin with metal wire has higher mean value of tensile strength than specimens of heat-cure acrylic resin without metal wire (table 1), figure (3).

This may be due to adding of metal wire give support to acrylic materials and give higher tendency and ability to with stand the higher strength. Similar results are observed by **(16)** who showed improvement of the tensile strength of repaired acrylic resin joint reinforced with wire or glass fiber, also this explanation agree with (17) how stated that stain less steel wire reinforcement produced significantly higher tensile strength for both PMMA and BAC resin when compared with polyethylene fibers and glass fiber reinforcements.

Conclusion

It can be concluded that tensile strength of heat-cure acrylic resin specimens reinforced with metal wire has higher than that specimens of heat-cure acrylic resin without metal wire. This due to action of metal wire to give resistance to pressure direct force.

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