ISSN: 1812–1217

Effect of Thickness and Recycling on Transverse Strength of Relined Acrylic Resin Denture Base.

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الخلاصة

أهداف الدراسة : وتهدف هذه الدراسة لتقييم القوة العرضية لقاعدة الطقم الأكريلي المبطنة (معالجة إضافية بحمام مائي أو بالموجات الدقيقة)، وتقييم أفضل سماكة مادة تبطين قاعدة الطقم. **المواد والأساليب:** خمسة وثلاثون عينات أعدت من (Major)الراتنج الأكريلي الحراري بأبعاد 65×10×2.5±0.03ملم . (طول وعرض وسمك) على التوالي، لاختبار القوة العرضية (ADA specification No.12). تم فحص ثلاثة نسب مختلفة من سمك تبطين قاعدة الطقم واثنين من تقنيات المعالجة (دورة معالجة الموجات الدقيقة و دورة معالجة الحمام المائي). استخدمت التحليل الإحصائي من التباين (ANOVA and Duncan's range test) لمقارنة المجموعات. **النتائج** : لم يكن هناك اختلاف كبير في القوة العرضية بين اختلاف سمك مادة التبطين فيما يتعلق بقاعدة طقم الأسنان لكلا أساليب لمعالجة. وكان هناك اختلاف كبير في قوة عرضية بين المجموعة الضابطة ومجموعات التبطين (الموجات لدقيقة وحمام الماء). **الاستنتاجات** : إن النسب المختلفة من سمك مادة التبطين فيما يتعلق بقاعدة الطقم ليس لها تأثير محسوس على القوة العرضية لقاعدة الطقم المبطنة. تبطين قاعدة طقم الأسنان المعالج حراريا يقلل بصورة محسوسة القوة العرضية لقاعدة الطقم المبطنة.

ABSTRACT

Aims of the study: The aims of this study are to evaluate the transverse strength of relined acrylic denture base (additional curing by water bath or microwave), and to evaluate the best thickness of relining material in relation to denture base. **Materials and Methods:** Thirty five samples were prepared from Major heat cured resin in dimensions of 65×10×2.5±0.03mm (length, width and thickness) respectively, for the transverse strength test (ADA specification No.12). Three different ratios of relining material thickness to denture base were examined and two curing techniques (microwave curing cycle and the water bath curing cycle). Statistical analysis of variance (ANOVA) and Duncan's multiple range tests were used to compare the groups. **Results:** There was no significant difference in the transverse strength between the different thicknesses of relining material in relation to denture base for both curing methods .There was a significant difference in the transverse strength between the control group and the relined groups (microwave and water bath relining). **Conclusions:** Different ratios of thickness of relining material in relation to denture base had no significant effect on the transverse strength of the relined denture base. Relining the heat cure denture base material significantly decreases the transverse strength of the relined denture base.

Key words: Transverse strength**,** Relining**,** Additional cycle.

Hatim NA, AL-Omari AW. Effect of Thickness and Recycling on Transverse Strength of Relined Acrylic Resin Denture Base. *Al–Rafidain Dent J*. 2011; 11(1):1-5.
Received: 15/2/2009 ***Sent to Referees***: 22/2/2009 ***Accepted for Publication***:22/4/2009

INTRODUCTION

One popular method of compensating a compromised fit of existing denture is the reline. Reline defines as "the procedures used to resurface the tissue side of a removable dental prosthesis with new base material, thus producing an accurate adaptation to the denture foundation area" [(1)]. A necessary property of denture reline materials is adequate mechanical strength[(2,3)].

Since microwave technique applied for polymerization of acrylic resin, many studies have been conducted to compare several properties of acrylic resin cured by microwave technique and conventional water bath technique[(4,5,6,7)]. The present

study designed to evaluate and compare the two curing methods (water bath and microwave) and their effect on the transverse strength of denture base after relining by using the two curing methods. Also, to study the effect of different ratios of the thickness of relining material in relation to denture base on the transverse strength of relined denture base.

MATERIALS AND METHODS

Thirty five samples were prepared from Major heat cured resin in dimensions of 65×10×2.5±0.03mm. (length, width and thickness) respectively, for the transverse strength test (ADA specification No.12).

The samples of control group (without relining) were prepared by placing a sheet of wax against a glass slab, with 2.5 mm. thickness, the sheets were cut by using a sharp wax knife to the desired length and width. The surface of wax (smoothed by piece of tissue nylon type[8] against the glass slab was considered the polished surface, the other surface considered the tissue surface. Then stone was mixed with water in ratio of 28-32 gm of stone:100 ml. of water [9] and poured in the lower half at the flask and vibrated , a slurry of stone was applied to the polished surface of the samples and placed over the stone in the flask to prevent incorporation of air between the stone and wax. After the stone was set a separating medium was applied over the stone. Then the upper half of the flask was placed over and filled by stone.

After complete setting of stone, wax elimination was done by placing the flask (metal) in boiling water for 10 minutes and (FRP) flask in microwave oven at a high power for 1 minute. Then the two halves of the flask opened and boiling water with soap detergent was used to clean the surface of stone from remnants of the wax. After drying a separating medium was applied to both halves of the flask [9,10] . After that packing was done, the polymer was applied to the monomer placed in glass jar and mixed together, in ratio of 3:1 according to manufacture instructions, after the mixture reached dough stage, the two step packing technique was done by placing the acrylic dough in the moulds (over filled) and then polyethylene sheet was applied above the acrylic for trial packing, the flask was put under press between 800-2000 pounds , then the flask was opened and the excess of acrylic was removed by sharp wax knife, then left for 15 min. before curing [9,10]. Then curing of the samples in water bath for 30 min. at 73°C then 30 min. at 100°C (according to manufacture instructions) are done.

Relined Group Preparation :

The preparation of the relined denture base samples was done as following :

Three different ratios of relining material thickness to denture base were examined, they include (Figure 1):

1. Thickness 0.5 mm of relining material : 2 mm of denture base.
2. Thickness 1 mm of relining material : 1.5 mm of denture base .
3. Thickness 1.5 mm of relining material : 1mm of denture base .

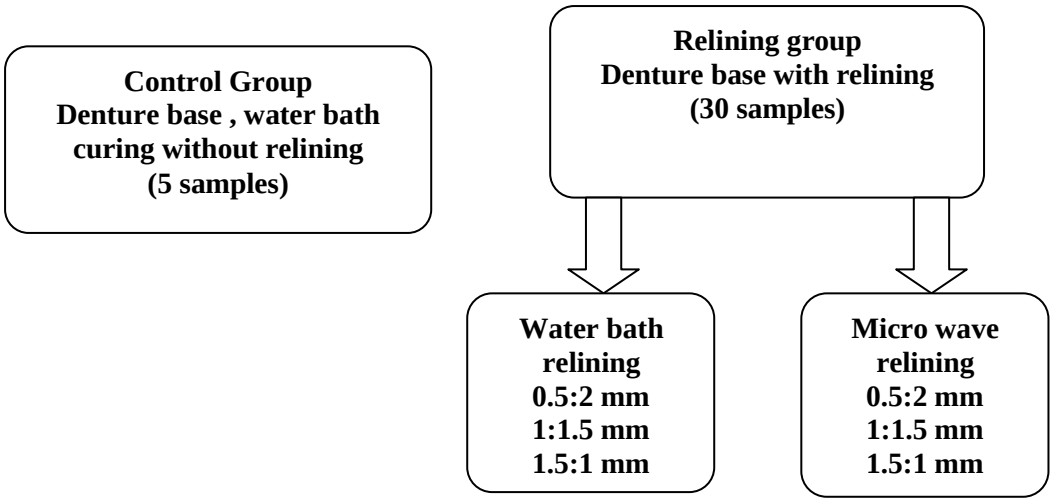

Figure (1) Experimental Design of the Study

Denture base preparation :

The samples were prepared by placing a sheet of wax over a glass slab with 2, 1.5,1 mm thickness the sample were cut by using a sharp wax knife to the desired length and width specified for each test. Then flasking, wax elimination, packing, curing and deflasking were proceed as in control group preparation. After that relining is done by placing the relining material over the tissue surface of the samples to obtain 2.5 mm thickness of denture base and curing is done according to table (1)

Table (1) : Curing Cycles Used in this Study

Curing Technique	Curing Cycle
Water Bath	30 min. at 73°C then 30 min. at 100°C (manufacture instructions)
Micro Wave	15 min. at 80 Watt. Per side then 1.5 min. at 500 Watt (Al-Azzawi)[18]

The transverse strength test was done in air by using a 3 points bending on an Instron testing machine. The devise was supplied with a central loading plunger and two supports ,with polished cylindrical surfaces of 3.2 mm. in diameter and 50 mm between supports. The supports should be parallel to each other and perpendicular to the central line. The tests were carried out with cross head speed of 5mm/min. The test samples held at each end of the two supports, and the loading plunger placed mid way between the supports. The surface of the denture base material was placed face down for each of the relined specimens. The samples were deflected until fracture occurred. The transverse strength were calculated using the following equation[11]:-

$$S = \frac{3PI}{2bd^2}$$

S= transverse strength (N/mm^2)
b= width of specimen (mm.)
d= depth of specimen (mm.)
I= distance between supports (mm.)
P= maximum force exerted on specimen (N)

RESULTS

Statistical analysis of variance (ANOVA) and Duncan's multiple range test (Tables 2 and 3) showed that the control group had significantly higher transverse strength (M±SD = 82.8 ± 1.64) value compared to the relined groups but, there was no significant difference in the transverse strength between the different thicknesses of relining material in relation to denture base and, there was a significant difference in the transverse strength between the additional microwave curing cycle and the water bath curing cycle (relining).

Table (2) Mean, Standard Deviation and Significance of the Transverse Strength (N/mm^2) of the Relined Samples.

	Ratio of relining to denture base 1:1.5mm		Ratio of relining to denture base 1.5:1mm		Ratio of relining to denture base 2:0.5mm	
	N	Mean±SD	N	Mean±SD	N	Mean±SD
Relining by water-bath	5	* 68.7 ± 1.643	5	* 69 ± 1.837	5	* 69 ± 1.06
Relining by microwave	5	* 75.3 ± 1.25	5	* 76.5 ± 1.5	5	* 75.3 ± 0.67

Control group (denture base without relining) M±SD = 82.8 ± 1.64N/mm^2, * = significant difference from the control group, N = number of samples, SD = standard deviation

Table (3) Duncan's Multiple Range Test for the Interaction Between Curing Method and Ratio of Relining Material to Denture Base.

	Ratio of relining to denture base 1:1.5mm			**Ratio of relining to denture base 1.5:1mm**			**Ratio of relining to denture base 2:0.5mm**		
	N	Mean	DMRT	N	Mean	DMRT	N	Mean	DMRT
Relining by water-bath	5	68.7	C	5	69	C	5	69	C
Relining by microwave	5	75.3	B	5	76.5	B	5	75.3	B

Control group (denture base without relining) DMRT = A; N = number of samples; DMRT = Duncan's multiple range test

DISCUSSION

The transverse (flexural strength) of a material is a measure of stiffness and resistance to fracture. Flexural strength tests were undertaken as these were considered relevant to the loading characteristics of a denture base in a clinical situation[12]. From the results of tables (2 and 3), it is clear that the denture base material after relining possessed significant lower transverse strength (69-76.5 N/mm²), than denture base material without relining (82.8 N/mm^2). The decrease in transverse strength of the relined denture base samples, could be mainly related to the adhesive failure under load between the reline and the denture base material[13]. This could be better explained through the molecular interaction between the active sites of the two resin surfaces (the parent resin and the added resin), all the active sites of the parent resin (denture base) are occupied by the previous curing of the material, while the added resin (reline material) has fully activated active sites. As a result, the compatibility between the two resins is inadequate which leads to weakening of the molecular interaction between the two resins, consequently weakening the mechanical properties of the base - reline complex[11]. This is in accordance with Baily [14] who stated that the cross linkage of surface molecules between parent acrylic resin and new reline resin was not as complete as initially polymerization process but clinically acceptable. Another explanation for the reduction in transverse strength could be due to the reheating of the old resin (denture base) to cure the added reline resin, that releases the internal stress inherent in heat cured acrylic base. This will result in a partial depolymerization and micro cracks formation within the resin from which crack propagation start, leading to decrease in strength and rigidity of the relined resin[15]. Heat stress may cause the water sorption of the polymer to increase because of an extension of the distance between the polymer chains. Water taken up into polymer acts as a plasticizer, thus the mechanical properties may be decreased [16]. For this reason Anusavice,[17] stated that for relining low polymerization temperature is desirable to minimize distortion of the remaining denture base . The results also showed that, the microwave curing method was better than water bath curing method in relining acrylic denture base. The microwave heating is energy conversion not conduction heating as in conventional water bath technique. In the microwave method, the monomer molecules are positively moved (rotated) by a high frequency electromagnetic field, their movement are the cause of the internal heat and the heat is only the consequence of their movements. So the microwave curing is much faster than a conventional water bath, and the degree of curing also increased [4,18,19].

CONCLUSIONS

There were no significance differences of transverse strength of relining thicknesses (0.5mm, 1mm, and 1.5mm) .

Relining the heat cure denture base material significantly decreases the transverse strength of the relined denture base for both curing methods. The microwave curing method in relining gives higher transverse strength values for the relined samples than water bath curing method.

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