

Recycling of Ceramic Bracket Using Burning Technique (An in vitro study)

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الخلاصة

المقدمة تعد عملية إعادة تدوير الحاصرات التقيوية من الأمور الشائعة في علاج تقويم الأسنان بسبب تكرار انفصالها عن سطح السن خلال فترة العلاج. وقد ظهرت خلال الفترة الماضية عدة تقنيات مثل الكيميائية والحرارية وباستخدام الليزر... الخ وكل هذه الطرق تهدف إلى إعادة استخدام الحاصرات التقيوية بنفس كفاءة نظيراتها الجديدة وتحمل كل واحدة منها عدد من الايجابيات والسلبيات. وستنظر في بحثنا هذا الى اختبار طريقة الحرق المباشر مع الحاصرات المصنوعة من مادة السيراميك. **الهدف من البحث:** يهدف البحث إلى اختبار كفاءة الحاصرات التقيوية المصنوعة من مادة السيراميك من حيث قوة التصاقها بسطح الأسنان ومقارنتها بكفاءة نظيراتها من نفس النوع. **المواد وطرق البحث:** تم تقسيم عينة البحث إلى قسمين، العينة المختبرة والعينة الضابطة. وتمت معالجة الحاصرات التقيوية المنتمية إلى العينة المختبرة بلصقتها ثم فصلها بعملية تشابه انفصال الحاصرة التقيوية عن سطح السن، ومن ثم أعيد تأهيلها بتقنية الحرق المباشر. بعد ذلك تم لصق جميع الحاصرات (في كلا العينتين) على سطوح أسنان طبيعية واختبرت كل واحدة منها من حيث قوة التصاقها بسطح السن. **النتائج:** أظهرت النتائج أن عملية الحرق أدت إلى إزالة بقايا المادة اللاصقة القديمة عن قاعدة الحاصرة تماماً، غير أنها أثرت بشكل سلبي على قوة التصاق الحاصرة التقيوية بسطح السن مقارنة مع نظيراتها من الحاصرات الجديدة. **الاستنتاجات:** لا ينصح بإعادة استخدام الحاصرات التقيوية المصنوعة من مادة السيراميك بعد إعادة تأهيلها بطريقة الحرق المباشر وذلك للضعف الشديد الذي يصيب قوة التصاقها بسطح السن.

Abstract

Aims: To study burning technique is tested for recycling of orthodontic ceramic bracket, then both recycled bracket and control (as received) bracket are tested for shear bond strength. **Materials and Methods:** The study samples are divided into two groups, control and test group. The brackets in the test group bonded, de-bonded and then recycled using burning technique, then both control and test group brackets are bonded to the buccal surface of premolar teeth and tested for shear bond strength. **Results:** The result showed a complete removal of the composite resin from recycled bracket base, but a dramatic decrease in shear bond strength in recycled brackets compared with that of the new one. **Conclusions:** Ceramic bracket could not be efficiently used after recycling with burning technique since it will have a very low retention property.

Key words: Ceramic bracket, Recycling, Burning technique, Shear bond strength

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INTRODUCTION

Fixed orthodontic appliances that combine acceptable esthetics for the patient and optimal technical performance for the orthodontist constitute a very desirable combination⁽³⁾. Ceramic bracket is strongly bonded to enamel surface, so that even chipping of the enamel or bracket fracture may occur during the de bonding process. To overcome this problem, variable instruments and improved techniques

have made it possible to remove ceramic brackets without fracturing them or damaging enamel surface. However, bond failures can occasionally occur, making it necessary either to re-bond the dislodged bracket or to bond a new one⁽⁴⁾.

Recycling consists basically of the removal of residual glue or remnant bonding material from de-bonded bracket without distortion of bracket slot dimensions (width, depth) and delicate mesh^(1,9).

Ceramic brackets are much more brittle than conventional metallic brackets and therefore are more likely to fracture than to distort on de-bonding. This ensures that intact de-bonded brackets do not lose their precisely machined angulations, torque, and base contour⁽³⁾. Some orthodontists recycle or re-bond their used bracket without removing the old adhesive from the bracket base, eliminating the cost of commercial reconditioning⁽¹²⁾.

Recycle produces bracket as good as new bracket and not only remove the residual bonding material but also sterilizes and polishes at the same time^(6,11).

Materials and Methods

Preparation of Test Sample Teeth

the test sample composed of 20 Ceramic Brackets (FASCINATION 2, Dentaurem, Germany) and 20 permanent first premolar teeth divided into two groups, the control group and the test group.

After extraction, the teeth were cleaned out of soft tissue remnants and stored initially in 70% ethyl alcohol; then the samples were kept in sterilized normal saline at room temperature to prevent dehydration. Then the sample teeth (of Both of the groups) prepared by hand scaler to remove any supragingival calculus and debris, a glass slide was placed on the surveyor table that is previously adjusted in parallel plane with the base. The teeth were then fixed on the glass slide in an upright position using soft wax at the root apex. The analyzing rod of the surveyor was used to orient the teeth, so that the force could be applied parallel to the tooth surface. After that each tooth was embedded in self curing acrylic resin⁽¹⁰⁾, using a metal ring, which was placed around the tooth. So after complete setting of the acrylic, each tooth was rechecked for the proper orientation with the help of the analyzing rod (Figure 1).



Figure (1): Test sample teeth fitted vertically into a metal cylinder filled by acrylic resin.

Preparation of the recycled bracket sample:

The preparation of the test sample takes the following two steps:

Step one: Ten ceramic brackets were bonded to a glass slap using light cured orthodontic composite resin(Transbond XT, USA) following the steps advised by the manufacturer, then the brackets were removed from the glass slap using "Bachmann" Needle Holder.

Step two: Each bracket was then exposed to torch flame (Pros'Ket tool, TAIWAN) , the process continued until the bracket has a cherry red appearance. After that, the bracket was immersed immediately into a cold water(0 C⁰ – 5 C⁰) the composite starts cracking and completely detached from the bracket base, after that a gentle cleaning by a brush was applied to the bracket base in order to complete the recycling process.

Bonding to the Sample Teeth

Ceramic brackets of both groups (10 for recycled group and 10 for control group) were bonded to the middle third of the buccal surface of the prepared sample teeth using acid etching and light cured composite following using the same technique as advised by the manufacturer for both groups.

Shear bond strength measurement were done with a universal shear and ten-

sile testing machine (UNCONFINED SHEAR TESTING MACHINE./ENGLAND) with cross head speed of 0.5 mm/minute⁽²⁾. The force at bond failure was recorded in kilograms, and the stress in Mega Pascal (MPa) was calculated by converting the bond force into Newton, and then dividing this by the bracket base bonding area in square meters (figure 2).



(A)



(B)

Figure (2): A. Metal blade of shear bond tester fitted on the bracket base. B. Universal shear bond tester machine during shear bond testing.

Resin remnant

Stereo microscope “Zeisis Co., Germany is used at 20X magnification power to detect any remaining composite resin on bracket base after recycling procedure.

Statistical Analyses

The results from the two groups were statistically tested by the use of paired sample T-test at ($P \leq 0.05$) using statistical computer program (SPSS V.15) to expose the difference between the results of both groups.

Results

1. Resin Remnant

Microscopically, for all the test sam-

ples, the bracket base is completely free from bonding composite resin remnants

2. Shear Bond Strength

The descriptive statistics (mean, standard deviation, minimum and maximum values) of the shear bond strength for the control and test groups (Table 1) showed that the mean value of the control group is higher than that of the test group which mean that the first time bonded bracket has a higher shear bond strength than that of the recycled one, and the variance analysis showed that the difference between the two groups is statistically highly significant.(Table:2)

Table (1): Descriptive statistical analyses of the control and test groups

| Groups | N | Mean MPa | Std. Deviation | Std. Error Mean |
|---------------|----|----------|----------------|-----------------|
| Control group | 10 | 7.3758 | 3.43849 | 1.08735 |
| Test group | 10 | 2.3027 | 1.70833 | .54022 |

Table (2): Independent variable t-test for detection of significant difference between control and test groups

| Groups | N | Mean MPa | df | t- value | Sig. (≤ 0.05) |
|---------------|----|----------|----|----------|----------------------|
| Control group | 10 | 7.3758 | 18 | 4.178 | .001 |
| Test group | 10 | 2.3027 | | | |

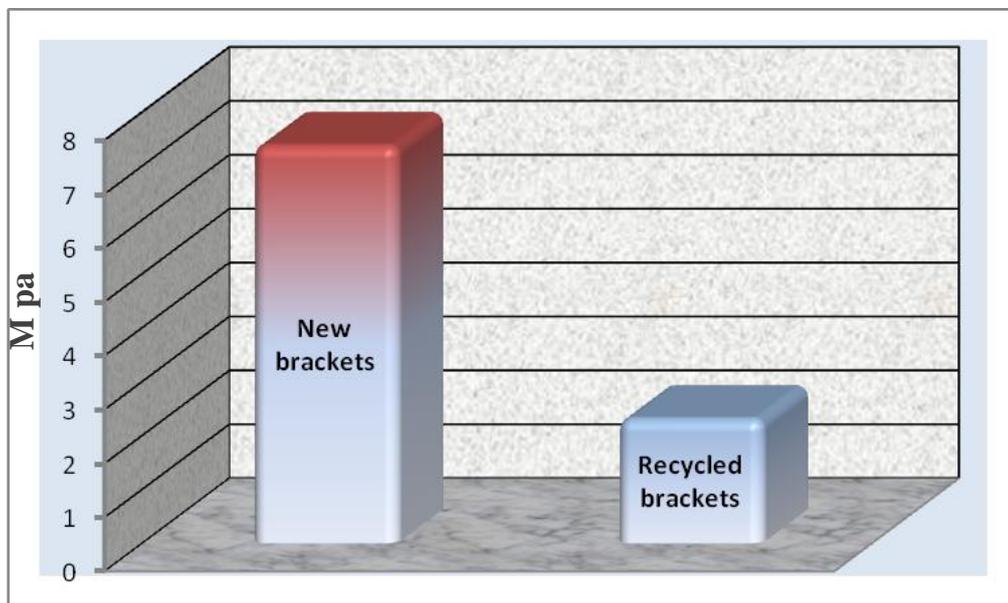


Figure (3): Bar diagram show the mean deference in shear bond strength value between the control group (New bracket) and the test group (Recycled bracket) measured in mega Pascal (M pa)

Discussion

The method used in this research utilized the dimensional change difference between the ceramic and composite material when exposed to rapid thermal change, that difference will result in cracking and separation of the composite resin from the ceramic and bracket base during thermal change, ceramic bracket is the only bracket type that can benefit from that characteristics, since damage may occur in other bracket types by excessive heat applied for recycling. While ceramic bracket has an excellent heat resistance and maintain their slot dimension and form after recycling.

The significant lowering in the shear bond strength of the recycled ceramic bracket appear to be due to :

- 1- When the composite resin cracked and displaced from the ceramic bracket, it partly removes the irregularities provided by the zirconium layer at the base of the bracket which is applied by the manufacturer to increase bond strength by providing mechanical retention with the composite resin. This is in agreement with previous researches⁽⁵⁾.
- 2- The partial removal of the silane layer at the bracket base, which is a material applied by the manufacturer to add chemical bond to the mechanical reten-

tion, and this is in agreement with previous researches⁽³⁾.

Those two possible reasons make it clear that recycled ceramic bracket have lower shear bond strength than the new one, and failed to maintain the minimum bond strength as recommended for retention of orthodontic bracket^(7,8).

Conclusions

Although the color and dimension of Ceramic brackets are stable after recycling by burning technique. It loses most of its retention properties which makes it improper for orthodontic treatment when recycled by burning technique.

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