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Evaluation of enamel surface damage after debonding using three different pliers "An in vitro study"

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Abstract

This study aims to compare the effectiveness of three different pliers in debonding stainless steel and ceramic brackets, also to evaluate enamel surface damage and the site of bond failure after debonding.

Sixty premolars, extracted for orthodontic purposes, were divided into 3 groups of 20. The enamel surfaces were examined with 10X magnifying lens. Two types of bracket (stainless steel and ceramic) was bonded and debonded in each group using: conventional debonding pliers, bracket removal pliers, and ligature wire cutter. After debonding, the enamel surfaces were inspected under a stereomicroscope to determine the predominant site of bond failure. Then stereomicroscope was used to evaluate enamel surface damage after the removal of residual adhesive.

The enamel surface damage showed a statistically significant difference in ceramic bracket groups, whereas, it was statistically insignificant in stainless steel bracket groups. The amount of the adhesive remained on the tooth surface was statistically insignificant in both stainless steel and ceramic bracket groups. The predominant failure site was within the adhesive itself for both types of brackets.

The enamel surface damage that results from debonding of ceramic brackets was higher than that found with the stainless steel brackets especially with the use of bracket removal pliers "used in this study"

Key words: enamel surface damage; debonding; pliers.

Introduction

The objectives of debonding are to remove the attachment and all the adhesive resin from the tooth and to restore the tooth surface as closely as possible to its pretreatment condition without inducing iatrogenic damage to it [(1)]. To achieve these objectives, correct bonding and debonding techniques are of fundamental importance. There are several factors involved in this procedure, the most important of which are the instruments used for bracket removal, the armamentarium for resin removal, and the type of adhesive used [(2)].

The ceramic brackets when introduced were considered a viable alternative to stainless steel, particularly since it offered a significant improvement in esthetic.

Unfortunately, unlike stainless steel, the material cannot be flexed slightly to aid debonding and the high initial forces that are necessarily applied in the removal of ceramic brackets at the end of orthodontic treatment have become an area of concern (3).

Several complications have been encountered during debonding of these brackets than the stainless steel such as enamel tears out, enamel fractures, enamel cracks, and bracket failure (4,5,6).

The amount of enamel damage was related to the type of bracket, bracket base design, and adhesive system used (7,8,9).

To reduce the rate of irreversible enamel surface damage, several methods of debonding of ceramic brackets have been suggested. These include: Conventional methods in which pliers or wrenches are used, an ultrasonic method that requires the use of special tips, and electrothermal methods that involve transmission of heat to the adhesive through the bracket. Although all three methods have been used successfully to debond brackets, the use of pliers to apply shear or tensile force is perhaps the most convenient and the most popular. Improvements in bracket engineering, debonding methods and debonding instruments have been made, yet enamel damage during the debonding of ceramic brackets continues to be a matter of concern for the clinician (10,11).

Materials and method

Sixty premolars, extracted for orthodontic purpose, were selected for this study after examination with 10X magnifying lens **(12)** and transillumination light to be grossly intact, with no enamel cracks, caries, restorations, or surface irregularities, and without any pretreatment with chemical agents such as hydrogen peroxide **(13,14)**.

The teeth were cleaned and stored in normal saline containing 1%thymol, at room temperature 37°C **(15)**.

Retentive wedge shaped cuts were made along the sides of the roots of each tooth to increase the retention of the teeth inside the self-cured acrylic blocks **(16)**.

Three teeth were fixed in marked position on a glass slide in a vertical position, 2cm apart, using soft sticky wax at the apex of the root , so that the middle third of the buccal surface of each tooth was oriented to be parallel to the analyzing rod of the surveyor to kept the buccal surface of tooth parallel to the applied force during the debonding test **(17)**.

Then 2 L-shaped metal plates, were painted with a thin layer of separating medium and placed opposite to each other in such way to form a box around the vertically positioned teeth with the crowns protruding .The powder and liquid of the cold cured acrylic were mixed and poured around the teeth to the level of the cementoenamel junction of each tooth **(18,19)**. After setting of the cold cured acrylic resin, the L-shaped metal plates were removed,and simple adjustment of the acrylic blocks was done using the portable engine.

The 60 premolar teeth were randomly divided into 2 groups containing thirty teeth each according to the type of brackets (stainless steel and ceramic). Then according to the type of pliers used for bracket removal each group was subdivided into three subgroups (each contain 10 teeth) with color codes (G, green; R, red; B, blue) on the base of the acrylic block to prevent any associations between the groups.The groups are described as follows:

*****Stainless steel brackects ['Ultratrim®] :***

Group G: debonded with conventional debonding pliers; the specimens were numbered from 1 to 10.

Group R: debonded with bracket removal pliers; the specimens were numbered from 1 to 10.

Group B: debonded with ligature wire cutter; the specimens were numbered from 1 to 10.

*****ceramic brackets [REFLECTION®]:***

Group G: debonded with conventional debonding pliers; the specimens were numbered from 1 to 10.

Group R: debonded with bracket removal pliers; the specimens were numbered from 1 to 10.

Group B: debonded with ligature wire cutter; the specimens were numbered from 1 to 10.

The buccal surface of each tooth was polished using non-fluoridated pumice with a rubber cup attached to a low speed handpiece for 10 seconds [11,20], then each tooth was washed with water spray for 10 seconds, and dried with oil-free air for 10 seconds [19].

The enamel on the buccal surfaces of the teeth was etched with 37% phosphoric acid gel for 30 seconds, rinsed for 30 seconds, and dried with air spray for 10 seconds [21].

The commercial adhesive resin (Resilience/OrthoTechnology) was used. Each bracket was positioned in the middle third of the buccal surface and parallel to the long axis of the tooth, pushed firmly toward the tooth surface, and then the excess resin was removed.

Immediately after bonding ,a constant load (200 gm) was placed on the bracket for 10 seconds [11] to ensure that each bracket was seated under a constant force and to ensure a uniform thickness of the adhesive [22,23,24].

The specimens were kept in a medium containing normal saline with thymol at 37°C for 7 days [25].

Before the beginning with mechanical debonding, each specimen was placed into a vise that positioned the tooth surface parallel to the direction of force application.

Mechanical debonding methods:

Group G (st.st & Ce.): Bracket removal with the conventional debonding pliers placed at the base of the bracket, while its beak rests on the tip of enamel surface avoiding unnecessary torque of the tooth (Bennett et al, 1984; Zarrinnia et al, 1995) then the instrument was rotated towards the occlusal edge of the bracket until the bracket was removed [26].

Group R (st.st & Ce.): The tips of the bracket removal pliers were placed under both sets of occlusal and gingival tie-wings and above the base of the bracket. The handles of the instrument were squeezed until the angled ends of the handles met, and the pliers were Rotated towards the occlusal edge of the bracket until the bracket was removed [26].

Group B (st.st & Ce.): Bracket removal with the ligature wire cutter that placed at the base of the bracket, and a slight amount of squeezing pressure applied to the handles of cutter until debonding occurred [2].

Before removing excess adhesive and polishing the enamel surfaces, each tooth was assessed with the adhesive remnant index (ARI) in which the debonded bracket and the enamel surface of each tooth were inspected under a stereomicroscope (magnification 20X) with the following classifications: 0, no adhesive on the tooth surface; 1, less than half of the adhesive on the tooth surface; 2, more than half of the adhesive on the tooth surface; and 3, all adhesive remaining on the tooth surface [27 ,28 ,29,,30].

The residual adhesive was removed with a 12-bladed tungsten carbide finishing bur with a low-speed handpiece and air as coolant, one bur was used for each group and the specimens were cleaned with pumice and water by using rubber cups [10].

Stereomicroscope was used to evaluate enamel surface damage after the removal of residual adhesive. Photographs of post treatment enamel surface taken at 40X magnification for the three techniques. The images captured by the stereomicroscope transferred to a computer. Then analyzed and assigned a score to each photo according to the following scale *(Kitahara-Céia et al, 2008):* **0 ,** enamel surface free from cracks or tear-outs; **1,** enamel surface with cracks***;*** **2,** enamel surface with tear-outs***;*** **3,** enamel surface with cracks and tear-outs.

Results and Discussion

Adhesive Remnant Index (ARI)

- ***Stainless steel bracket groups*** **(table 1)**:
  - ***Group G (st.st):*** using conventional debonding pliers showed (score 0) in 50% of teeth, (score 1) in 40% of teeth and (score 2) in 10% of teeth. Score 3 not appeared in this group**.**
  - ***Group R (st.st)*****:** using bracket removal pliers showed (score 0) in 30% of teeth, (score 1) in 50% of teeth and (score 2) in 20% of teeth. Score 3 not appeared in this group.
  - ***Group B (st.st)*****:** using ligature wire cutter showed (score 0) in 20% of teeth, (score 1) in 40% of teeth and (score 2) in 20% of teeth. Score 3 appeared in 20% of teeth.

  The ARI indicated that there is only 6.66 %of this group showed a failure site at bracket /adhesive interface and this could be related to a very high interlocking of adhesive material to the coarse mesh retentive mean at bracket base, which is even higher than that found between the adhesive and etched enamel surface resulting in 33.33% of this group failed at the enamel / adhesive interface.

  More over, the retention of the adhesive to the enamel surface, by etching, and to the bracket base, by coarse mesh retentive mean, is greater than that within the adhesive itself resulting in about 59.99 % of this group failed within the adhesive material itself (score 1&2).

- ***Ceramic bracket groups*****(table 2)**:
  - ***Group G (Ce.):*** using conventional debonding pliers showed (score 0) in 20% of teeth, (score 1) in 40% of teeth and (score 2) in 40% of teeth. Score 3 not showed in this group.
  - ***Group R (Ce.):*** using bracket removal pliers showed (score 1) in 10% of teeth, (score 2) in 40% of teeth and (score 3) appeared in 50% of teeth. Score 0 not appeared in this group.
  - ***Group B (Ce.):*** using ligature wire cutter showed (score 1) in 40% of teeth, (score 2) in 30% of teeth and (score 3) appeared in 30% of teeth. Score 0 not showed in this group.

  Failure site occurred at the enamel/adhesive interface in only 6.66% this mean that there is a high interlocking of the adhesive material with the etched enamel surface ,on the other hand failure at the bracket/adhesive interface occur in only about 1/3 of this group, this could be related to the bracket base retention means which are dovetail with horizontal and vertical grooves allowing easy penetration of the adhesive between them into the undercut areas with good air evacuation from peripheries preventing air entrapment.

- ***Enamel surface damage evaluation***

The results are given in **Table (3&4)** that demonstrates scores of enamel damage for all groups of [stainless steel& ceramic] brackets.

The number of enamel cracks that result from debonding was relatively similar between the three types of pliers; this could be related to the type of material used in the construction of stainless steel bracket, which is less brittle than the ceramic, resulting in deformation of the bracket itself rather than damaging the enamel surface during debonding.

In general the number of enamel cracks that result from debonding of ceramic brackets was higher than that found with the stainless steel brackets and according to these results, the best performing groups—those exhibiting the least damage on the enamel surface were the stainless steel bracket groups.

Clinical Cosiderations

1-Bracket removal pliers should be avoided in ceramic bracket removal.

2-don't use ceramic brackets on structurally damaged teeth, non vital teeth, teeth with cracks, heavy caries and large restorations; this may increase the incidence of enamel fracture at debonding**.**

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Fig.1: mechanical debonding using conventional debonding pliers.

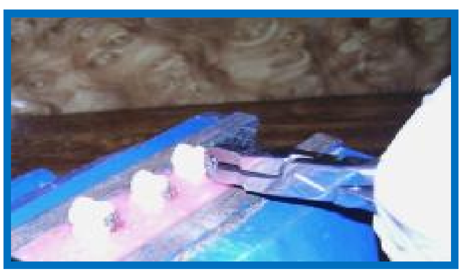

Fig.2: mechanical debonding using bracket removal pliers.

Fig.3: mechanical debonding using ligature wire cutter.

Table 1. Frequency Distribution of ARI for Stainless steel brackets groups.

Score	ARI		
	St. St.		
	group G	group R	group B
0	5	3	2
1	4	5	4
2	1	2	2
3	0	0	2
total	10	10	10

Table 2. Frequency Distribution of ARI for Ceramic brackets groups.

Score	ARI		
	Ceramic		
	group G	group R	group B
0	2	0	0
1	4	1	4
2	4	4	3
3	0	5	3
total	10	10	10

Table 3. Frequency Distribution of enamel surface evaluation for Stainless steel brackets groups.

Score	Enamel Damage		
	St. St.		
	group G	group R	group B
0	9	8	8
1	0	1	1
2	1	1	0
3	0	0	1
total	10	10	10

Table 4. Frequency Distribution of enamel surface evaluation for Ceramic brackets groups.

Score	Enamel Damage		
	Ceramic		
	group G	group R	group B
0	8	3	8
1	2	3	1
2	0	2	1
3	0	2	0
total	10	10	10