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# Comparative assessment of enamel surface after debonding the ceramic brackets using three different techniques - An invitro study

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## Abstract

**Context**: Many clinicians refrain from using ceramic brackets because of the many potential problems, as well as the difficulty encountered during debonding. Although all types of ceramic brackets present the clinician with a challenge during debonding, mechanically retained brackets have adequate bond strength and cause minimal enamel damage. Several debonding techniques have been used to overcome problems during debonding. Hence a comparative study was undertaken to assess and compare the enamel surface after debonding the ceramic brackets using narrow bladed debonding Pliers, thermal Debracketing and Er-YAG laser.

**Aims**: To assess and compare the enamel surface after debonding the ceramic brackets using narrow bladed debonding Pliers, thermal Debracketing and Er-YAG laser.

**Methods and Material**: Forty premolars extracted for orthodontic purpose were divided into 4 groups of 10 each that included three groups with different debonding techniques and fourth groups as control group. The labial surfaces of the teeth were conditioned and Ceramic brackets were bonded on the labial surface of the premolars. After bonding using three different techniques, the enamel surfaces were photographed with a magnifying loupe (1.5x) in an optical stereomicroscope with a digital camera. The photographs were evaluated for quality of enamel surface according to a predetermined scale by Adhesive remnant index scores.

**Results and Conclusion**: There was significant difference in ARI scores following different debracketing methods. The post hoc test evaluation showed that ARI rating was lowest with group B laser technique compared to group A narrow beaked plier and group C thermal debonding. Of all the methods, Er-YAG laser scanning gave a good surface following the removal of the ceramic bracket.

**Keywords**: Ceramic Brackets, Debonding, Enamel surface, debonding plier, Thermal Debonding, Er-YAG laser.

## Introduction

Like general dentistry, the orthodontic specialty felt the need to provide the public with a more esthetic or invisible Orthodontic appliance. Being esthetic is the unique characteristic of ceramic bracket as compared to metal bracket.[1] Although the ceramic brackets are most esthetic, many clinicians refrain from using them because of its own limitations, as well as the difficulty encountered during debonding.[1]

Creramic brackets are brittle in nature and have resulted in a higher incidence of bracket failure during debonding.[2] Improper debonding techniques can be painful, time consuming and damaging to the enamel. The enamel cracks and fractures reported during debonding has raised questions regarding the safety of various procedures used to detach these attachments.[2]

Less energy is required to cause fracture of ceramic brackets as their tensile strength is greater than that of stainless steel brackets[3] This phenomenon is related to “fracture toughness” or the ability of the material to resist fracture and ceramic brackets have substantially less fracture toughness when compared to stainless steel brackets.[3]

The bond strengths of ceramic brackets with different retention mechanisms such as mechanical, chemical and combination of both were studied by few authors.[4,5] Mechanically retained ceramic brackets showed adequate bond strength and caused minimal enamel damage, although all types of retention mechanisms of ceramic brackets presented a challenge to the clinicians.[1]

To overcome the problems during debonding, several debonding techniques including ultrasonic instruments, warm-air dryers, wood-burning pens, electrothermal devices, and lasers have been used.[6] These techniques cause thermal softening of the adhesive resin by heat conductivity thus helping in debonding.[4] Studies concerning this issue emphasize laser debonding, which is an effective way that works by controlling the amount of thermal energy delivered.[7]

A Sharp edged instrument should be placed at the enamel-adhesive interface and a "slow gradual squeezing" force should be applied until bracket gets debonded as recommended by Swartz.

He also explained that this method of force concentration was analogous to tile delamination of two pieces of bonded wood where twisting one piece from the other required great forces.[6] Whereas wedging force applied by a chisel at the interface of the two usually led to less destruction and required significantly less force to separate.[7]

Hence a comparative study was undertaken to assess and compare the enamel surface after debonding the ceramic brackets using narrow bladed debonding Pliers, thermal Debracketing and Er-YAG laser.

## Methodology

Forty healthy premolars extracted for orthodontic purpose were included in the study.

Grossly destructed tooth, tooth with enamel hypoplasia, abraded tooth or tooth with cervical caries were excluded in the study.

Forty premolars extracted for orthodontic purpose were divided into 4 groups of 10 each depending on the type of debonding they underwent.

Group A: Debonding using plier

Group B: Er-YAG Laser exposure debonding

Group C: Thermal debonding

Group D: Control group

All the extracted teeth were stored in distilled water before preparation and testing. The teeth were mounted with a stone base covering the root and exposing only the crown (Figure 1), cleaned and polished with non-fluoridated pumice, rinsed with water and dried with oil free compressed air. The labial surfaces of the teeth were conditioned with 37% phosphoric acid for 30 seconds, followed by thorough washing and drying. Ceramic brackets (3M Unitek Gemini Clear) were bonded on the labial surface of the premolars using the adhesive Transbond XT (3M Unitek) and cured with a light-curing unit for 20 seconds each on the mesial and distal sides, as recommended by the manufacturer (Figure 2).

After bonding, all the samples were coded and were stored in water before subjecting to debonding. After 48 hours the specimens were removed from the water, debonded according to the group methods and were sent to the laboratory for stereomicroscopic evaluation. The enamel surfaces were photographed with a magnifying loupe (1.5x) in an optical stereomicroscope with a digital camera.

Ceramic brackets were bonded and debonded in each group using 3 different techniques as follows:

**Group A: Debonding using narrow bladed plier** (Figure 3)

The brackets were debonded from all the specimens in this group using the Jaypee narrow bladed debonding plier. The blades were placed at the bracket base-adhesive interface and a gentle squeezing action was applied until the bond failure occurs.

**Group B: Er-YAG Laser method of debonding** (Figure 4)

The mounted teeth sample were immersed in a mug of warm water at a safe temperature of about 45 to 50$^{o}$C and vinyl debracketing plier was used. The blades were placed at the bracket base-adhesive interface and a gentle squeezing action was applied until the bond failure occurs.

**Group C: Thermal debonding** (Figure 5)

Each bracket in this study group was subjected to Er-YAG Laser at 4.2 W for 9 seconds with the scanning method. The brackets were debonded after 45 seconds of laser exposure.

**Group D: Control group**

**Evaluation of photographs**

After debonding, the surfaces of all the teeth were again photographed using Stereo- microscope. The photographs were evaluated for quality of enamel surface according to a predetermined scale by Adhesive Remnant Index scores (Figures 6-9).

**Results**

Table 1 showed the percentage distribution of ARI scores of the different groups. In group A, zero percent showed score 0, forty percent showed score 1, forty percent showed score 2, twenty percent showed score 3. In group B, thirty percent showed score of zero, fifty percent showed score 1, twenty percent showed score 2, zero percent showed score 3. In group C, zero percent showed score 0, thirty percent showed score 1, fifty percent showed score 2, twenty percent showed score 3. In group D there was a hundred percent of score 0.

Figure 10 showed the percentage distribution of ARI scores of different groups. In group A none of the samples were free of resin on the surface. Most of them showed scores 1 and 2. In group B thirty percent of the teeth were free of adhesive surface, fifty percent of them showed score 2 and none of them fell under score 3.Group C also presented with zero percent of teeth with adhesive free surface. Most of the cases debonded following hot water immersion showed score 3.

On the other hand all the teeth in Group D showed adhesive free surface as they were not bonded with ceramic brackets.

Table 2 showed descriptive statistics of the ARI scores of the different groups. Group A showed a mean score of 1.8±0.79 and standard equation of 0.25 with the minimum score of 1 and maximum score of 3 .Group B showed a mean score of 0.90±0.74 and standard equation of 0.23 with the minimum score of 0 and maximum score of 2. Group C showed a mean score of 1.90±0.74 and standard equation of 0.23 with the minimum score of 1 and maximum score of 3 .Group D showed a mean score 0 ±0 and standard equation of 0 with minimum and maximum score of 0.

Figure 11 showed the mean ARI score in the different groups. Comparison of the groups showed that the minimal scores were observed in group B followed by group A and group C.

Table 3 showed the result of the comparison of different groups using Kruskal Wallis test . The result showed that there is significant difference among the groups for the ARI scores and the P value was less than <0.001.

Table 4 showed the result of the post hoc test of Bonferroni . The difference in ARI scores was found to be significant between group A and group B (P<0.05), group A and group D (P<0.001).

The difference in ARI score was found to be significant between group B and group C (P<0.05) group B and group D (P<0.05), group B and group A(P<0.05) and as well as group C and group D (P<0.005).

There was no statistically significant difference observed between group A and group C (0.744).

Table 5 showed the result of the Chi square test of comparision of the groups . The chi square result 34.569 ( P value<0.001) denoted that there was a significant association between the scores and the groups.

**Discussion**

With the increase in the number of adult patients within past few years, ceramic brackets have gained popularity.[7] To minimize the metallic appearance of bands, the attempts to improve the esthetic appearance of the orthodontic resulted in the development of the bonded orthodontic bracket that used acid etch techniques.[8] Although ceramic brackets are esthetic, they are brittle in nature and they cause enamel fractures and cracks. The bracket retention mechanisms influences the forces applied during the debonding of ceramic brackets.[8,10-12]

The most common way of debonding ceramic bracket is through the use of specialized instruments or pliers that apply various forms of shear or tensile forces.[13] The technique is by applying a force bilaterally at the bracket-adhesive interface with a debonding plier or ligature cutter. On the other hand, debonding strengths of ceramic brackets has been evaluated using shear stress in the laboratory.[14] Shear bond strength of 60 to 80 kg/cm2 would be adequate to withstand clinical orthodontic forces as suggested by Reynolds.[15] The ARI scores were found to range be- tween 2 and 4 in the study done by Bishara et al which was similar to the ARI score of group A in our study.[1] The diamteral compression mean bond strengths for the three bracket types tested ranged from 6.6 MPa to 10.1 MPa.

The forces required to debond the ceramic brackets ranged from 9.2 to 0.28 MPa with the use of ultrasonic chisel. The low forces of ultrasonic chisel helped to prevent fracture of brackets and enamel during debonding.[16-21]

Although the forces applied by ultrasonic chisel were low, they provided a lot of discomfort to the orthodontic patient, hence this method isn't recommended without further developments.[2]

Several studies with many variables and techniques have evaluated the efficacy of lasers on debonding such as types of lasers, with same or different energy levels, brackets, resins and magnitude of stresses that are applied.[22-29] Laser light at wavelengths 248, 308, and 1060 nm at power densities between 3 and 33 W per square centimetre to debond ceramic brackets was used by Tocchio et al.[21] There was no enamel or bracket damage due to this laser debonding. The investigations reported that the laser energy degraded adhesive resin by thermal softening, thermal ablation or photoablation. The bonding agent when heated thermal softening takes place due to which the bracket slide of the tooth surface. If heating takes place faster and raises the temperature of the resin into its vaporizing range before the thermal softening occurs, thermal ablation takes place due to which the bracket blows off the tooth surface as a result of thermal ablation. When the energy levels of the bond between bonding resin atoms rapidly rises above their dissocation energy levels, leading to decomposition of the material, the bracket blows off the tooth surface due to photoablation.[6]

Er-YAG laser has similar effects on the adhesive laser but it appears to have lesser thermal effects than Nd:YAG laser.[30,31] Accroding to study done by Oztoprak et al[6] laser aided debonding was efficient for debonding ceramic brackets without enamel tear out or bracket fractures. The ARI scores was increased by Er-YAG and this decreased the enamel fracture. The Er-YAG laser is effective was effective in reducing the shear bond strengths of orthodontic polycrystalline ceramic brackets for safe removal from tooth. The results of our study were similar to this.

**Conclusion**

The following conclusions were drawn from the study:

1. The mean ARI score of group A was 1.8 ± 0.7 with minimum score 1 and maximum score of 3.
2. The mean ARI score of group B was 0.9 ± 0.7 with minimum score of 0 and maximum score of 2.
3. The mean ARI score for group C was 1.90 ± 0.74 with minimum score of 1 and maximum score of 3.
4. Comparison using Kruskal-Wallis test and chi square test showed that there is significant difference in ARI scores following different debracketing methods.
5. The post hoc test evaluation showed that ARI rating was lowest with group B laser technique compared to group A narrow beaked plier and group C thermal debonding.
6. Of all the methods, Er-YAG laser scanning gave a good surface following the removal of the ceramic bracket.

Very few studies are reported with the ARI index following debonding of the ceramic brackets. There are no in vitro or clinical studies performed using the hot water method of debonding the ceramic brackets. Hence a direct comparison of our results could not be made. Further in vivo studies should be undertaken with large sample size.

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