

Comparison of Adhesive Remnant Index on the Surface of Enamel after Debonding Using ARI score: An *in-vitro* Study

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Abstract

Background: Proper bonding of brackets is one of the important components in orthodontic treatment, which helps in transferring forces to the teeth to appreciate teeth movement. Initially, etching (surface preparation) was done on the surface of the teeth by acid (37% phosphoric acid) to bond brackets directly to the teeth. Later, with the introduction of lasers, surface preparation was done using lasers, which was considered as an alternative and better technique when compared with the conventional acid technique. The aim of the study is to compare the adhesive remnant index (ARI) among three groups and to evaluate the amount of adhesive remaining on the enamel surface after debonding between Group A and Group B, Group A and Group C using ARI score. **Results:** The ARI Index shows that Group 3, the laser-etched group, had a major bond failure at the favorable site, with the highest score values between scores 1 and 3. The ARI index of groups A and B showed the highest score values between scores 4 and 5, with major bond failure at the unfavorable site. **Conclusion:** Analysis of variance and Chi-square test revealed statistically significant difference between three different groups on assessing ARI index. Group C (laser etched group at W. 1 mJ and 10Hz) showed better bond strength at a clinically acceptable level and also had major bond failure at the favorable site which produces least damage to the enamel surface.

Keywords: Adhesive remnant index, Lasers in orthodontics, Orthodontic brackets.

INTRODUCTION

The evolution of orthodontic materials started from the past five decades till the present, which has a unique progress curve characterized by periods of intense activity with many developments.^[1] Direct bonding of brackets to enamel has to be accomplished with various enamel conditioning procedures which can be either chemical or mechanical.^[2] In 1955, Buonocore reported a simple method of increasing the adhesion of acrylic filling materials to enamel surfaces in which alteration on the enamel surface is done by chemical treatment using phosphoric acid.^[3] In 1965 with the advent of epoxy resin bonding, Newman began to apply these findings to direct bonding for orthodontic attachments.^[4]

Even though Phosphoric acid etching is the gold standard method of enamel preparation, studies have demonstrated that this kind of attachment has disadvantages like enamel decalcification which leaves the enamel surface susceptible to acid attack (cavity formation).^[5]

Silverstone concluded that maximum retention can be obtained when enamel surface is treated with 20–50% phosphoric acid in comparison with other acid such as 10% polyacrylic acid.^[6]

Bishara in 1993 showed that the use of polyacrylic acid resulted in lower bond strength when compared with phosphoric acid when brackets were bonded to enamel surface.^[7]

The study primarily aims to investigate the differences in adhesive remnant index (ARI) scores among three distinct groups. Furthermore, the research will specifically compare the amount of adhesive residue left on the enamel surface post-debonding between Group A and Group B, as well as between Group A and Group C. This evaluation will utilize the ARI scoring system to quantify and analyze the adhesive remnants.

The difference in ARI among the three groups' scores in the present study was statistically significant ($P = 0.04$). Multiple

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comparisons between groups showed that the ARI scores of Group A and Group C had a significant difference at $P = 0.01$; a borderline significance was observed between Group A and B at $P = 0.09$ (Table 1).

MATERIALS AND METHODS

Samples collected were mounted in the PVC pipes filled with self-cure acrylic resin, where, the crown surface was above the level of acrylic resin, so that it can be held in the clamp of the universal testing machine. The enamel surface of each tooth was first polished using pumice. The teeth were then washed with distilled water and air-dried.

The mounted samples were divided into three groups, 20 each based on the type of etching technique and its parameters:

- Group A (Purple color) ($n = 20$) = Conventional acid etching (Etched using 37% phosphoric acid)
- Group B (Green color) ($n = 20$) = Er: YAG Laser irradiation at 1W, 100 mJ and 10 Hz power output
- Group C (Yellow color) ($n = 20$) = Er: YAG Laser irradiation at 1.5W, 150 mJ, and 10 Hz power output.

RESULTS

Table 2 highlights significant differences in ARI scores among the three groups ($P = 0.04$). Group A primarily exhibited scores of 5 (65%) and 4 (30%), while Group B showed a predominance of scores 4 (45%) and 5 (25%). Group C displayed a more balanced distribution, with scores 1, 3, and 5 each at 25%, and scores 2 and 4 at 20% and 10%, respectively. The graph 1 visually represents the ARI scores, showcasing that bond failure at favorable sites (scores 1, 2, and 3) was highest in Group C (55%), followed by Group B (30%) and Group A (5%). Table 3 further details pairwise comparisons, revealing a statistically significant difference between Group A and Group C ($P = 0.01$). However, no significant differences were found between Group A and Group B ($P = 0.09$) or between Group B and Group C ($P = 0.49$).

DISCUSSION

Tooth movement can be clinically accomplished by means of removable and fixed appliances. Even though removable appliances are less visible when compared with fixed appliances, they cannot move teeth in all three planes of space as effectively as full-banded appliances.^[8] The introduction of the direct bonding technique in contrast to banding has given rise to dramatic changes in the practice of clinical orthodontics with several advantages,^[9] such as enhancing the ability of the individual to remove plaque, minimizing soft-tissue irritation and hyperplastic gingivitis, eliminating the need for separation, facilitating the application of attachments to partially erupted teeth, eliminating post-treatment band spaces, minimizing the risk of decalcification with loose bands, facilitating the detection and treatment of dental caries and for a better esthetic appearance for the recipient. Acid conditioning changes the enamel surface from a low-energy hydrophobic surface to a

Table 1: ARI scores

Score	Remnant adhesive on enamel surface
Score 1	100% composite remaining on the enamel tooth surface
Score 2	More than 90% of the composite remaining on the enamel tooth surface
Score 3	More than 10% and <90% of the composite remaining on the enamel surface
Score 4	<10% of the composite remaining on the enamel surface
Score 5	No composite remaining on the enamel surface

ARI: Adhesive remnant index

Table 2: Comparison of adhesive remnant index scorings among three groups using Chi-square test

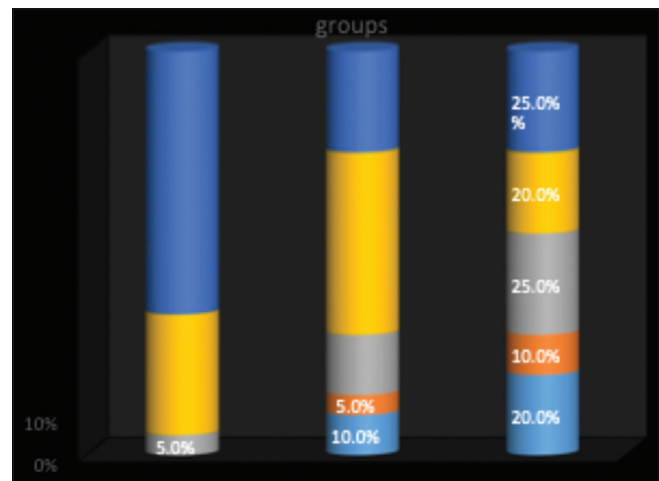
ARI score	Group A		Group B		Group C		P-value
	n	%	n	%	n	%	
Score 1	0	0.0	2	10.0	4	20.0	0.04*
Score 2	0	0.0	1	5.0	2	10.0	
Score 3	1	5.0	3	15.0	5	25.0	
Score 4	6	30.0	9	45.0	4	20.0	
Score 5	13	65.0	5	25.0	5	25.0	

*Statistically significant

Table 3: Multiple pairwise comparison of ARI scores b/w groups using Chi-square test

Groups	Group A versus group B	Group A versus group C	Group B versus group C
P-value	0.09	0.01*	0.49

ARI: Adhesive remnant index



Graph 1: Adhesive remnant index scorings between 3

high-energy hydrophilic surface resulting in increased surface tension and wettability.^[10]

Meijer and Smith suggested that a bond strength of 8MPa is required for orthodontic treatment.^[11] Sallam and Arnout stated that the clinically accepted level of shear bond strength is 13.59MPa. Group C showed a similar value of 13.55MPa.^[12]

Hosseini *et al.* concluded that the laser groups with an output power of 1W and 1.5W had better bond strength than acid etch group.^[13] The study by Sallam and Arnout^[12] showed that the laser group with an output power of 1.5W had better shear bond strength and was at a clinically acceptable level when compared to the acid etched group. The remnant adhesive on the teeth was assessed post-debonding according to the ARI. The scores were given according to the amount of residual resin material adhered to the enamel surface. The amounts of adhesive remnant can be evaluated qualitatively by two methods:

- a. 4-point scale by Artun and Bergland (Original method)
- b. 5-point scale by Bishara and Trulove (Modified method).^[14]

During the ARI evaluation, it was found that a predominant amount of bond failure occurred between the adhesive-enamel interface in Group A and Group B. In Group C, predominant bond failure was found between the adhesive-bracket and within the adhesive interface. This suggests that Group C laser etching is more favorable for bonding as it causes the least damage to the enamel surface.

CONCLUSION

Group C showed better bond strength at a clinically acceptable level and its ARI evaluation showed major bond failure at a favorable site and produced least damages to the enamel surface.

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