

Reliability of the Adhesive Remnant Index Score System with Different Magnifications

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ABSTRACT

Objective: To test the hypothesis that adhesive remnant index (ARI) scores show no differences when examined under different magnifications.

Materials and Methods: The study included 80 upper human premolars. Stainless steel brackets were bonded to the specimens with Transbond XT light cure adhesive and Transbond Plus Self Etch Primer (3M Unitek, Monrovia, Calif, USA). The brackets were debonded 24 hours after bonding with a universal testing machine (LLOYD Instruments, Segensworth, Fareham, England) at a cross head speed of 2.00 mm/min. The adhesive remnant was evaluated after debonding with the naked eye and under 10× and 20× magnification (Mag) using the 4-point scale described by Årtun and Bergland.

Results: ARI scores were significantly different at different magnifications ($P = .018$). Scores were not significantly different when evaluated with the naked eye and under 10× Mag ($P = .102$). Scores were significantly different under 20× Mag and with the naked eye ($P = .014$); under 20× Mag, score 0 decreased from 12 to 6 and score 2 increased from 14 to 20 and also under 20× Mag and under 10× Mag ($P = .046$); the under 20× Mag score 1 decreased from 40 to 38 and score 3 increased from 14 to 16.

Conclusion: ARI scores were significantly different under 20× Mag, where score 0 decreased and score 2 increased compared with the naked eye, while score 1 decreased and score 3 increased compared with 10× Mag. (*Angle Orthod.* 2009;79:773–776.)

KEY WORDS: Adhesive remnant index; Different magnifications

INTRODUCTION

Årtun and Bergland¹ used an Adhesive Remnant Index (ARI) system to evaluate the amount of adhesive left on the tooth after debracketing. This index system was developed on the basis of a pilot study of 20 extracted teeth and the criteria were as follows: score 0 = no adhesive left on the tooth; score 1 = less than half of the adhesive left on the tooth; score 2 = more than half of the adhesive left on the tooth; and score 3 = all adhesive left on the tooth with a distinct im-

pression of the bracket mesh. Over the years, ARI scores have been one of the most frequently evaluated aspects in studies on orthodontic adhesives. Because the adhesive remnant score system is qualitative and subjective, many attempts have been made to modify the original system, or to develop new quantitative methods that can be used to more accurately assess the adhesive remnant. To more accurately evaluate the adhesive remnant qualitatively, many studies expanded the ARI system that was developed by Årtun and Bergland¹ into 5 or 6 scales.^{2–6} Studies such as that of O'Brien et al⁷ aimed to introduce a more precise technique for describing the resin remnant; this study used a quantitative method whereby a magnified image of the enamel is digitized and the amount of remaining resin is expressed as a percentage of bracket base area.

To accurately score the ARI is important because it is an important factor to be considered in the selection of orthodontic adhesive. Studies^{8–11} have debated whether the differences in ARI scores reflect a difference in bond strength between the enamel and the

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Accepted: October 2008. Submitted: August 2008.

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adhesive for the different adhesive systems, but adhesive systems that show less adhesive remnant on the tooth has been advocated for easier and safer removal of residual resin after debonding.^{12,13} Accurate evaluation of the adhesive remnant, which is crucial in the final process of enamel cleaning after debonding, is needed for satisfactory removal and restoration of the enamel surface to as close to pretreatment condition as possible. Most laboratory studies on the bond strength of orthodontic brackets have examined teeth and brackets under 10× magnification (Mag) to assess and score the adhesive remnant,^{3,4,6,10} although laboratory studies designed for evaluation of the enamel surface after debonding and cleaning of the surface have used more sophisticated methods such as scanning electron microscope, finite element analysis, and 3-dimensional profilometry.^{14–16} Clinically, evaluation of the adhesive remnant and the enamel surface after bracket debonding and enamel cleanup generally is done by visual inspection under a dental operating light.

Because of the small surface area of the orthodontic brackets and thus of the enamel surface area covered by the adhesive remnant, group gap and overlaps could appear during evaluation of the ARI. No studies have attempted to study the effect of magnification on the reliability of the ARI score system.

The objective of this study was to test the hypothesis that adhesive remnant index (ARI) scores show no differences when examined under different magnifications.

MATERIALS AND METHODS

This study examined 80 human upper premolars extracted for orthodontic purposes and stored in an aqueous solution of thymol (0.1% wt/vol). The teeth were fixed in self-curing acrylic resin placed in plastic rings of 30 mm diameter with only the buccal surface exposed and oriented parallel to the bottom of the mold.

The buccal surface of each tooth was cleaned with nonfluoridated oil-free pumice paste and then was rinsed with water and dried with an oil-free air spray. Upper premolar stainless steel brackets (Mini Twin, American Orthodontics, Sheboygan, Wis, USA) were bonded to the specimens with Transbond XT light cure adhesive and Transbond Plus Self Etch Primer (3M Unitek, Monrovia, Calif, USA), in keeping with the manufacturer's instructions. The specimens were then stored for 24 hours in distilled water before undergoing testing at 37°C.

A universal testing machine (LLOYD Instruments, Segensworth, Fareham, England) was used to debond the brackets at a cross head speed of 2.00 mm/min

Table 1. Frequencies of ARI Scores for the 3 Magnifications^a

	N	ARI Scores			
		0	1	2	3
Naked eye	80	12	38	14	16
10× Mag	80	6	40	20	14
20× Mag	80	6	38	20	16

Chi-square = 8.089; $P = .018$.*

^a ARI indicates adhesive remnant index; Mag, magnification.

* Significant at $P \leq .05$.

Table 2. Wilcoxon Signed Ranks Test Comparing the 3 Magnifications^a

	z	Significance
Naked eye–10× Mag	–1.63	.102
Naked eye–20× Mag	–2.44	.014*
10× Mag–20× Mag	–2.00	.046*

^a Mag indicates magnification.

* Significant at $P \leq .05$.

with an occlusal-lingual load applied to the bracket, producing a shear force at the bracket tooth interface.

Evaluation and scoring of the adhesive remnant were carried out by the same evaluator under the different magnifications chosen for this study. Evaluation was carried out with the naked eye, under 10× Mag, and under 20× Mag. The specimens were evaluated under each magnification in a separate session and randomly in each session. The ARI evaluation used the 4-point scale of Årtun and Bergland,⁵ where 0 indicates no adhesive left on the tooth surface, implying that bond fracture occurred at the resin/enamel interface; 1 indicates that less than half the adhesive is left on the tooth surface, implying that bond fracture occurred predominantly at the resin/enamel interface; 2 indicates that more than half the adhesive is left on the tooth surface, implying that bond fracture occurred predominantly at the bracket/resin interface; and 3 indicates that all adhesive is left on the tooth surface with a distinct impression of the bracket base, implying that bond fracture occurred at the bracket/resin interface.

A Friedman test followed by a Wilcoxon signed ranks test was used to investigate any significant differences in ARI scores between the different magnifications.

RESULTS

The ARI score distribution for the different magnifications is shown in Table 1. The results of the Friedman test show that the ARI score evaluation was significantly different under different magnifications ($P = .018$). The Wilcoxon signed ranks test (Table 2) shows a significant difference when scores were evaluated

under 20× Mag and with the naked eye ($P = .014$); under 20× Mag, the number of score 0 decreased from 12 to 6, and the number of score 2 increased from 14 to 20. ARI scores were also significantly different when evaluated under 20× Mag and under 10× Mag ($P = .046$); under 20× Mag, the number of score 1 decreased from 40 to 38, and the number of score 3 increased from 14 to 16. ARI scores were not significantly different when evaluated with the naked eye and under 10× Mag ($P = .102$).

DISCUSSION

The ARI score system has proved to be of value in studies of orthodontic adhesive systems. It is a quick and simple method that needs no special equipment. However, its reliability requires investigation, with special attention on the effects of magnification on evaluation of the adhesive remnant. The results of this study show that there was a significant difference between ARI scores when the evaluation was done at different magnifications. A significant difference between scores can be seen when evaluation was done with the naked eye and under 20× Mag. Changes in scores were noted mainly in 2 areas: score 0 and score 2. Under 20× Mag, the number of score 0 decreased from 12 to 6, and the number of score 2 increased from 14 to 20. A significant difference between scores was also evident when evaluation was done under 10× Mag and under 20× Mag. Under 20× Mag, the number of score 1 decreased from 40 to 38, and the number of score 3 increased from 14 to 16. Generally, under the higher (20×) magnification, there was a tendency for the lower scores to decrease and the higher scores to increase as compared with the lower (naked eye and 10×) magnifications. An interesting result was that no significant difference was seen between ARI scores when evaluation was done with the naked eye and under 10× Mag. Differences in the number of the scores in the 2 groups were noted, but statistically, these differences were insignificant. This indicates that there is no evidence to support the assumption made in most of the papers on orthodontic adhesives that included an evaluation of the ARI scores—that evaluation of ARI scores under 10× Mag is more accurate than evaluation of these scores with the naked eye.

Studies targeting the reliability of the ARI score system are not common. In his study on the bond strength of orthodontic brackets, Oliver¹⁷ examined the reliability of the system and found that interobserver and intraobserver variability is low when the system is used, but the reliability was evaluated under the same magnification. David et al¹⁸ evaluated the accuracy of the ARI score system compared with quantitative mea-

surements; this study compared the system as described by Årtun and Bergland¹ and by Bishara and Trulove,¹⁹ wherein ARI scores were designed from 0 to 3 and from 1 to 5, respectively, vs a quantitative method wherein the area covered with the adhesive remnant was measured from photographs with a sonic digitizer and a linear magnification factor of 30.8×. Graphs representing qualitative scores and quantitative measurements converted to percentages showed that the qualitative methods currently used to assess the amount of remnant adhesive left on the enamel surface after debonding did not closely reflect the quantitative area measurement of the remnant adhesive. Investigators concluded that the quantitative methods are preferable if accurate evaluation of the adhesive remnant is required. However, quantitative evaluation of the adhesive remnant is more sophisticated, requires special equipment, and is more time consuming than qualitative evaluation, and it is especially difficult to apply clinically.

A higher magnification may offer a way to perform more accurate evaluation of the adhesive remnant, but further investigation is needed to reach a standard magnification.

CONCLUSIONS

- The original hypothesis was rejected; the statistics showed significant differences when ARI scores were evaluated under different magnifications.
- At higher (20×) magnification, the tendency is for lower scores to decrease and higher scores to increase as compared with lower (naked eye and 10×) magnifications.
- Under 20× Mag, score 0 decreased from 12 to 6, and score 2 increased from 14 to 20 compared with naked eye scores; also, score 1 decreased from 40 to 38 and score 3 increased from 14 to 16 compared with 10× Mag scores.

ACKNOWLEDGMENTS

Special thanks to the manufacturers 3M Unitek and American Orthodontic for supplying the materials for this study.

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