



The Impact of Dental Magnification Loupes on The Quality of The Enamel Surface Roughness After Orthodontic Brackets Debonding Using Different Methods (An In-Vitro Experiment)

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Abstract

Background: This review aims to assess the enamel surface roughness change following brackets debonding and adhesive cleaning using two types of adhesive removal burs with and without wearing dental loupes. **Material and Methods:** Eighty human premolars were extracted before starting orthodontic treatment and used as the samples for the current study. All samples were attached with metal brackets and then divided at random into four groups (n=20) by wearing Loupes and using tungsten carbide bur (LT), wearing Loupes and using stainbuster bur (LS), using tungsten carbide bur without wearing loupes (WLT) and using stainbuster bur without wearing loupes (WLS). All groups were subjected to these methods by using low-speed handpiece. Enamel surface roughness (ESR) measurements were done using Stylus Profilometry (Surface roughness tester Time[®]3200) as (R1) before the bonding time point and (R2) after the adhesive cleaning time point.

Results: The outcomes were statistically analyzed via the Independent T-test ($P \leq 0.05$). The results displayed statistically considerable differences between the resin cleaning methods related to enamel surface roughness by wearing loupes or not and using tungsten carbide or stainbuster burs. **Conclusion:** Wearing dental loupes during the debonding procedure could improve the quality of the adhesive removal technique. In addition, a stainbuster burs system showed a better adhesive removal method than tungsten carbide bur.

Introduction:

People's assessment of their malocclusions and tooth abnormalities has risen as they have become more aware of facial and dental aesthetics, which leads to growing numbers of young and older individuals seeking orthodontic treatment for "aesthetic purposes" (1,2).

The ideal orthodontic adhesive would compromise between being strong enough to keep the appliance in place during treatment and being easily removable afterward (3). Bonding brackets to teeth is based on acid etching, which results in high porosity that facilitates resin infiltration into the enamel (4).

Fixed orthodontic therapy completion procedures include removing brackets and other attachments and restoring the tooth surface to its pre-therapy state as feasible (5,6,7). In orthodontic offices, burs are typically used for debonding, including tungsten carbide in low-speed or high-speed handpiece, stainbuster and composite finishing burs. Working without damaging the enamel surface requires careful consideration of the type of bur used. Other popular alternatives are Polishing paste, pumice, and polishing disks. The enamel surface can be damaged because different methods produce different degrees of polishing, scratches, and abrasions (8). The polishing system's effectiveness relies on the elasticity of the core substance in which the coarse-grained is inserted, the particle's toughness, the particle volume of the polishing methods, the tools and their shape (cups, discs, wheels, and cones), and the debonding process (9,10). Different polishing technologies, such as diamond or carbide burs, polishing discs, diamond-impregnated rubber wheels, cups, discs, and pastes, are accessible (11).

Adhesive tags might retain the orthodontic appliance's erosion byproducts and colorants (12,13). The roughening of enamel caused by

adhesive clearance may result in discoloration. Adhesive residuals may alter enamel color due to internal changes generated by the adhesive resin's physicochemical interaction and outward changes caused by the superficial absorption of food coloring agents. Nevertheless, even in laboratory settings, removing all adhesive residue from the tooth surface is tough without using powerful magnification (5). Previous research has shown that bonding, debonding, and polishing may modify enamel's surface roughness and color, influencing dental appearance (5,14,15,16).

Currently, no technology permits the removal of adhesive residues without tooth surface damage. The primary cause is acid erosion, resulting in resin infiltration inside the enamel (17).

Magnification by using dental loupes is not a novel concept in dentistry. There is widespread dissemination of the notion that better visibility and a more upright workplace posture are beneficial (18). However, attention to detail is of the utmost importance for our work. The development of ceramics, lingual appliances, mini bracket systems, and self-ligating systems continues. We might also increase our patient treatment level with magnification and boost our physical health (19). Bauman, in his research, recommends frequently using magnification loupes while removing the resin following bracket debonding (20). In addition, a combination of enhanced light intensity and magnification assisted in seeing the adhesive residue on the enamel surface, hence decreasing enamel injury during the cleaning operation (21).

Quantitative techniques, such as Surface Roughness Testing and Atomic Force Microscopy, may be recommended for assessing and comparing the damage produced by various resin remnant removal processes due to the potential for comparative measurement of tooth surface roughness (22). Profilometry is thus a method for extracting

topographical information from a surface. Profilometry determines surface characteristics, step levels, and surface roughness. The profilometer measurement may be accomplished using a physical probe (Stylus profilometer) or light. Stylus profilometers are used in several measuring applications because of their simple settings and user-friendliness. They produce direct, highly reproducible, and high-resolution profiles independent of optical reflection or surface texturing⁽²³⁾.

Material and Methods:

Sample preparation, bonding and debonding

Two hundred fifteen Maxillary first premolars from a human being were gathered, which were taken from those needing orthodontic treatment. After removal from the patient's mouth, water was used to clean the teeth from any remaining blood and debris. Each tooth was thoroughly rinsed to remove soft tissue remnants and debris⁽²⁴⁾. The teeth were kept at room temperature in distilled water. Weekly changes to the distilled water were made to avoid bacterial growth.⁽⁶⁾ The 80 samples were picked after checking by 10X magnifying lens and visible light cure machine⁽²⁵⁾, and those that had the following criteria were excluded: presence of internal stains, enamel decalcifications, decay, fluorosis, enamel defects, restorations and cracks in the tooth. Eighty Equilibrium® 2 type upper first premolar metal brackets (Dentaurum company, Ispringen, Germany) were utilized. The upper premolar bracket is a Roth system with a slot size of 0.022×0.030 inches, a torque of -7 degrees, and an angulation of 0 degrees. The width of the bracket is 3.45 mm.

After cleaning, the teeth were kept in a container containing normal saline at room temperature. The apical root part of the teeth was cut to have a flat apex. Every three teeth were fixed in a transversally rectangular metal mold. A slight coating of separating media

(Vaseline) was applied to the inner walls of the metal mold, and then the stone and water were mixed to a creamy form and emptied between the teeth to the near so that only the buccal surface of the crowns could be seen. After the setting of the stone, the metal mold was removed, and the resulting holes were filled with stone. The stone block was adjusted to have well-defined borders, as shown in (Figure 1). After being mounted, the samples numbered 1 to 80. The buccal surfaces of the teeth were polished using non-fluoridated pumice and a nylon brush.

Over the buccal surface of the crown, each sample had a square piece of paste tape positioned on it. A circular aperture was cut out of the tape, which allowed a working area for bonding, adhesive removal, color analysis using a spectrophotometer, and surface roughness measurements⁽²⁶⁾.

The teeth were bonded using Transbond XT and the standard acid etching technique. For fifteen seconds, 37% phosphoric acid was used to etch the enamel surface, washed with an air-water spray for twenty seconds, and dried the teeth with air for ten seconds⁽⁵⁾. Each sample was supplied with a bracket, the base of the bracket covered with a smear layer of the separating medium (vaseline) using a micro brush and then lined with Transbond XT resin paste material. The bracket was then located in the working area (about at the center of the buccal surface) and pressed on the tooth surface using a bracket holder tweezer, then cured by curing light intensity 1000 mw/cm² for twenty seconds. Following bracket bonding, the specimens were kept in artificial saliva in sealed containers in an incubator at 37°C for one week to reach equilibrium in their water absorption and simulate the condition of the brackets in the oral cavity. The synthetic saliva was altered every 72 hours with a new solution. Afterward, each bracket was removed using a bracket holder tweezer, leaving a uniform rectangle of bonded composite resin approximating the mesh of the maxillary first premolar bracket base.

Adhesive removal methods

The samples were distributed into four groups (each containing twenty teeth), as follows:

(LT) group: The adhesive removal was done by wearing dental loupes (Ergo custom-made dental loupes 6X with led light (Admetec, United States)) as shown in (Figure 2) and using tungsten carbide bur, 9-blade (Orthometric, Brazil) in low-speed contra-angle handpiece (10000-20000 rpm), then the teeth polished with rubber cups and pumice.

(LS) group: The adhesive removal was done by wearing dental loupes and using a stainbuster zirconia multiblade bur (Broca em zircônia multilamina), active tip diameter: 3mm, length: 23mm from (Morelli Ltda, Brazil) in low-speed contra-angle handpiece from 10000 to 20000 RPM, then the teeth polished with disposable burs for finishing (Ponta descartável), tip diameter: 3mm, length: 23mm from (Morelli Ltda, Brazil).

(WLT) group: Tungsten carbide burs were used to remove the resin in a low-speed contra-angle handpiece (10000-20000 rpm) without wearing dental loupes, then the teeth were polished with rubber cups and pumice.

(WLS) group: The adhesive removal was done using stainbuster zirconia multiblade bur in low-speed contra-angle handpiece from 10000 to 20000 RPM without wearing dental loupes, then the teeth were polished with Ponta disposable burs for finishing.

In groups (LT) and (LS), adhesive removal was accomplished when the enamel surface was smooth to the touch, and dental loupes and chair light showed no evidence of resin.

In groups (WLT) and (WLS), adhesive removal was accomplished when the enamel surface was smooth to the touch, and no evidence of resin was shown by the naked eye and dental chair light ^(27, 28, 29).

Surface roughness measurements

Measuring ESR was done using a profilometer with a microneedle to scan surface roughness to evaluate a surface's overall texture. The outcomes were indicated by the measure "roughness average" (Ra). Average roughness value (Ra): the arithmetic means of the peak height and valley depth from a mean line. This parameter specifies the total surface roughness in micrometers (μm). Typical Enamel surface roughness (ESR) ranges between 0.59 to 0.66 μm ⁽³⁰⁾. Ra was measured using a surface profilometer (Time@3200 Surface Roughness Tester; TIME Group Inc, Beijing, China), as shown in (Figure 3) with a 0.25 mm cutoff and 0.1 mm/s speed. The surface roughness of each specimen was measured in three points; the mean value of the three points was considered as the mean surface roughness (Ra) ^(6, 31, 32, 33).

Surface roughness was evaluated for all the samples by a single blind evaluator at two-time points:

- Before bonding the brackets (R1).
- After adhesive removal (R2).

Statistical analysis:

The statistical analysis was done using Microsoft Excel, IBM SPSS V26 and Minitab V.17. The Shapiro-Wilk test was utilized to investigate data distribution (which was normally distributed). The mean and standard deviations were statistically calculated using an Independent t-test, which is used to compare the means of the two groups. In addition, The level of significance was fixed at 5% and $P < 0.05$ was considered statistically significant.

Result:

There was a significant difference in the enamel surface roughness level between R1 for the (LT+ LS+WLT+ WLS) group (0.679 μm) and R2 for (LT+ LS+ WLT+

WLS) group (0.590 μm) through the using two different burs systems (tungsten bur and stainbuster bur) reduced the enamel surface roughness level after adhesive removal less than before bracket bonding as shown in (Table 1).

In addition, there was no significant change in the enamel surface roughness (ESR) for the (LT+WLT) and (LS+WLS) groups before bracket bonding (R1) nearly at the same level between (0.662 to 0.691 μm). However, there was a significant difference in the enamel surface roughness level after adhesive removal (R2) between the tungsten carbide bur and stainbuster bur systems. The stainbuster bur system has less enamel surface roughness measurement (0.525 μm) than the tungsten bur system (0.632 μm), as shown in (Table 2 and Table 3).

Moreover, a T-test was employed to contrast the (LT) and (LS) groups at the time points (R1) and (R2). In time point (R1), there was no significant difference in the ESR for the samples, nearly at the same level (Ra between 0.610 to 0.695 μm). Also, there was no significant difference in the ESR in time point (R2) using the two different burs systems (tungsten bur and stainbuster bur), although the (LS) group has less surface roughness (Ra 0.553 μm) than the (LT) group (Ra 0.623 μm), as shown in (Table 4).

However, according to the T-test in Table 5, which was used to compare between (WLT) and (WLS) groups. There was no significant difference in the ESR for the sample before bracket bonding (R1) nearly at the same level (Ra between 0.629 to 0.773 μm). Nevertheless, there was a significant difference in the enamel surface roughness after adhesive removal (R2) through the two different burs systems (tungsten bur and stainbuster bur). The (WLS) group has less surface roughness (Ra 0.498 μm) than the (WLT) group (Ra 0.641 μm).

The results obtained from Table 4 and Table 5 showed that using the loupes improved the vision level, resulting in reducing the difference in enamel surface roughness between the two different burs systems (tungsten bur and stainbuster bur).

Discussion:

More efficient bonding between enamel and adhesive resin can now be obtained, referred to as the development of composite resin and adhesive systems, leading to a decrease in the debonding rate of brackets. However, the enhanced resin adherence to the enamel surface makes resin removal after debonding more difficult. Therefore, the method utilized for removing remaining resin is crucial for preventing damage to the enamel surface, such as fissures, a rougher surface, wear, warming of the teeth, and pulpal injury⁽³⁴⁾.

The current study showed that ESR for all groups (after debonding and adhesive removal) was lower or similar to the pre-bonding enamel surface roughness. The baseline enamel surface roughness was maintained practically constant after adhesive removal by tungsten carbide bur 9-blade, then polishing with a rubber cup and pumice. On the other hand, the stainbuster burs system effectively reduced the ESR. Nevertheless, much research has revealed that the generality of the burs utilized to clear adhesive remnants after the end of orthodontics treatment may damage the tooth surface, owing to their form and Cutting intensity, independent of the procedure, and this is the same finding by Ulusoy⁽³⁵⁾. However, an extra uniform and smooth tooth surface with minimum scrapes was obtained by utilizing rubber cups and pumice paste, which agrees with Soares Tenorio et al.⁽²²⁾. In the present research, the causes for ESR after debonding to be lower or similar to the baseline ESR may refer to several points: First, the present study was in vitro study, and the only acidity exposed to the teeth was the 37% phosphoric acid for 15

seconds during a bonding procedure which agree with Zafar and Ahmed⁽³⁶⁾ finding. Secondly, the debonding and adhesive removal procedure depended on enamel superficial layer removal followed by polishing for more smoothing, and this finding agrees with Garg et al.⁽⁸⁾ and Soares Tenorio et al.⁽²²⁾. Thirdly, using a slow-speed handpiece could cause less enamel damage than a high-speed, which agrees with Özer et al.⁽¹⁵⁾. Fourthly, using dental loupes in this study enhanced the quality of debonding and adhesive removal procedures. Fifth, this study's debonding and adhesive removal procedure time was open (no limit) until the operator considered the tooth clean. In addition, the procedure depends also on the operator's skill and experience.

The present results were similar to those of Soares Tenorio et al.⁽²²⁾, who reported that tungsten carbide burs changed the ESR; however, following polishing, the ESR was comparable to the pretreatment condition. Although the fiberglass or stainbuster burs similarly changed the ESR, this change was less significant than that caused by the tungsten carbide burs, and it offered a final ESR comparable to the initial ESR.

In addition, it was shown that using a tungsten carbide bur alone (without polishing) during the debonding procedure raised the roughness of the enamel. Contrarily, the composite and stainbuster bur effectively reduced the enamel's surface roughness after debonding^(8,37). In contrast, Palmer et al., concluded that using 12 fluted carbide bur without polishing during the removal of brackets produced a smoother tooth surface than before orthodontic treatment, demonstrating a considerable difference in surface roughness⁽³⁸⁾.

The present study showed that using the loupes improved the vision level, enhancing the adhesive removal procedure and making it more efficient by improving the performance of tungsten bur in the (LT) group to be

equal to or near (LS) group, as explained in Table 4. While (WLS) group had a significantly better effect in reducing ESR than (WLT) group, as explained in Table 5. Consequently, this can minimize the ESR, enamel damage, bacterial accumulation, food pigments and teeth discoloration. Therefore, the outline of this present study found that the loupes group had better surface roughness and less discoloration than without loupes group, which agreed with the feedback of Karan et al.⁽³⁹⁾ and Baumann et al.⁽²⁰⁾.

Bacterial plaque adherence and stain development occur in the oral cavity due to rough surfaces. Decreased staining and plaque development result from less surface roughness^(39, 40). Baumann et al., highly advise utilizing dental loupes during adhesive removal techniques⁽²⁰⁾. Dental loupes improve the debonding process' quality, causing less enamel damage and composite residue⁽²⁰⁾. Moreover, Bernardi, Continenza and Macchiarelli, Established that utilizing a dental loupe during the debonding procedures considerably helps to preserve the enamel surfaces and efficiently remove the adhesive remnant⁽⁴¹⁾. Dental loupes proved useful, simple to use, and effective for assessing teeth surfaces and reducing ESR after adhesive removal^(42, 43).

On the other hand, Soares Tenorio et al., mentioned that using loupes affects the debonding quality, often results in less enamel damage and frequently leaves fewer resin residues. Due to the color matching between current adhesives and enamel, dental loupes act effectively in debonding⁽²²⁾.

Nevertheless, even in lab work, removing all adhesive residues from the tooth surface is almost difficult without using powerful magnification.

Limitation of this study:

It is possible that, like previous in vitro experiments, this research may not accurately portray the conditions within a

human mouth environment., as the complex variations in temperature, humidity, acidity and plaque formation. Furthermore, measuring the surface roughness of the convex buccal surface of the premolar tooth is one of the limitations in this study, while a flat surface is required for easier measurements, which could be obtained from the labial surface of the human or bovine upper central incisors teeth.

Conclusions:

- 1- Dental loupes can enhance the adhesive removal procedure and make it more efficient. Consequently, this can decrease

the ESR, enamel damage and enamel discoloration.

- 2- A stainbuster burs system at low-speed handpiece showed better adhesive removal results, improving the enamel surface roughness and making teeth less susceptible to discoloration. In addition, after debonding and adhesive removal by tungsten carbide bur at a low-speed handpiece, it is recommended to use a polishing system.

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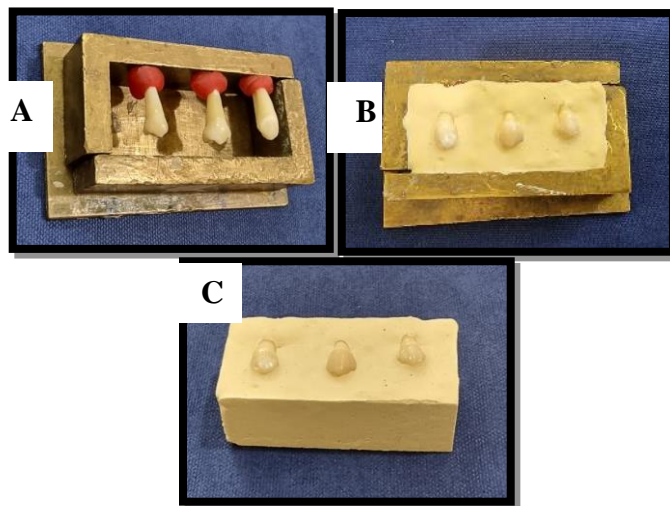


Figure 1: The steps of teeth mounting: A: each sample was positioned vertically on a side wall of the template, B: The stone emptied between the teeth to the near so that only the buccal surface of the crowns could be seen, C: The stone block was adjusted to have well-defined borders



Figure 2: Ergo custom-made dental loupes 6X

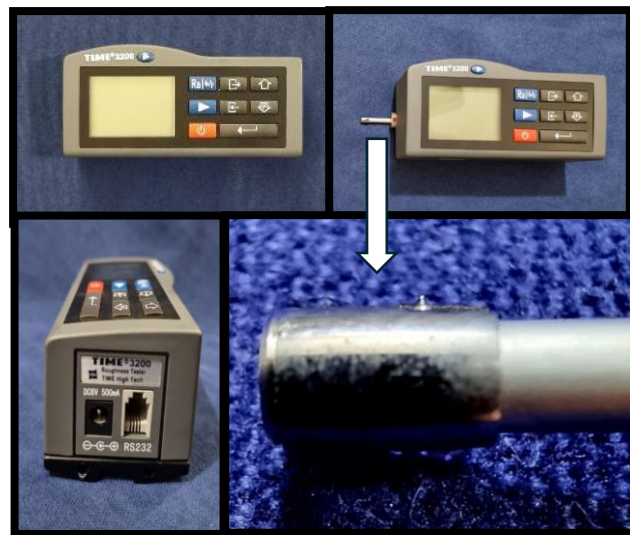


Figure 3: Stylus surface roughness tester time 3200 from different sides and removable stylus probe

Table 1 T-test to compare the groups (LT+ LS+ WLT+ WLS) between (R1) versus (R2) time points

Interval	Descriptive statistics				t-test	P-value	
	N	LT + LS + WLT + WLS Before bracket bonding (R1)		LT+ LS + WLT + WLS After adhesive removal (R2)			
		Mean in Ra	S.D.	Mean in Ra			S.D.
R1 for LT + LS + WLT + WLS versus R2 for LT + LS + WLT + WLS	80	0.679	0.234	0.590	2.5	0.013	

Table 2 T-test to compare the (R1) for groups (LT, WLT) versus the (R1) for groups (LS, WLS)

Interval	Descriptive statistics					t-test	p-value
	N	LT + WLT Before bracket bonding (R1)		LS + WLS Before bracket bonding (R1)			
		Mean in Ra	S.D.	Mean in Ra	S.D.		
R1 for LT + WLT versus R1 for LS + WLS	40	0.691	0.213	0.662	0.247	0.57	0.569

Table 3 T-test to compare the (R2) for groups (LT, WLT) versus the (R2) for groups (LS, WLS)

Interval	Descriptive statistics					t-test	p-value
	N	LT + WLT After adhesive removal R2		LS + WLS After adhesive removal R2			
		Mean in Ra	S.D.	Mean in Ra	S.D.		
R2 for LT + WLT versus R2 for LS + WLS	40	0.632	0.175	0.525	0.179	2.68	0.009

Table 4 T-test to compare the groups (LT) and (LS)

Time point	Descriptive statistics					Group difference		
	N	LT		LS		Mean difference	t-test	p- value
		Mean in Ra	S.D.	Mean in Ra	S.D.			
Before bracket bonding (R1)	20	0.610	0.206	0.695	0.222	-0.085	-1.255	0.217
After adhesive removal (R2)	20	0.623	0.146	0.553	0.188	0.070	1.311	0.198

Table 5 T-test to compare between the groups (WLT) and (WLS)

Interval	Descriptive statistics					Group difference		
	N	WLT		WLS		Mean difference	t-test	p-value
		Mean in Ra	S.D.	Mean in Ra	S.D.			
Before bracket bonding (R1)	20	0.773	0.192	0.629	0.271	0.144	1.941	0.060
After adhesive removal (R2)	20	0.641	0.203	0.498	0.169	0.143	2.410	0.021

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