Time Consumptions by Four Polishing Methods for in Vitro Removals of Orthodontic Adhesive Remnants

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Abstract

The purpose of this study was to compare the time consumptions for polishing methods postremoval of orthodontic brackets by using a white stone bur, a Sof-Lex disc, a tungsten carbide bur, and a sandblaster. After 80 human premolars had been bonded with orthodontic brackets, they underwent thermocycling and debonding the brackets. The residual adhesives on tooth surfaces were assessed by using a composite remnant index. The teeth with CRI score 4 (N = 71) were randomly into four groups, according to the polishing methods. A complete removal of the adhesives from the tooth was conducted by the respective procedures. Each of their time consumptions was recorded and analyzed by using a one-way analysis of variance and Bonferroni's post hoc test.

The results showed that using a tungsten carbide bur for such polishing purpose consumed significantly shortest time, followed by white stone bur, a Sof-Lex disc, and a sandblaster, respectively ($P < 0.001$). A tungsten carbide bur was thus illustrated to be appropriate for removing residual adhesives and should be used clinically to satisfy the patients in term of chair time.

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Introduction

Fixed orthodontic appliances have been used widely for the corrections of some malocclusions due to their several advantages. Resin adhesives are used for bonding the brackets with a tooth surface during the treatment procedures, are left on the surface after the treatment ended, and the residuals need some cleaning procedures. The processes consume clinical chair time, which affects the treatment time, orthodontists' fatigues, and patients' satisfactions.

Some polishing methods for orthodontic adhesive removals and their minimal harm to the enamel surface have been documented. They include the use of hand scaler, ultrasonic scaler, LASER, and numerous types of burs for rotary instrument, that is, green stone, white stone, diamond, tungsten carbide, and composite burs, as well as Sof-Lex discs.[1-7]

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Although a sandblaster or an air-abrasion with aluminium oxide particles to remove the adhesive remnants has recently been recommended,[8-10] the most suitable time consumption is still controversial among several polishing techniques. Hence, this study aimed to compare the time consumptions for removing the adhesive remnants from the tooth surfaces postremoval of orthodontic brackets and postpolishing by a white stone bur, a Sof-Lex disc, a tungsten carbide bur, and a sandblaster.

Materials and methods

The in vitro study was approved by Naresuan University Ethical Committee, Phitsanulok, Thailand (IRB Number 0697/2017).

Eighty human maxillary premolars were gathered from Dental Hospital, Naresuan University. They possessed a normal morphology without previously bonded history, fluorosis, fracture, carious lesion, restorative material, crack line, or other dental defects on their buccal surfaces were included.

After cleaning, each tooth with its buccal surface 1.0-1.5 mm above the plastic pipe's rim was embedded in a plastic pipe, stabilized with self-curing acrylic resin (Figure 1A), and

recleaned with pumice slurry (Figure 1B).

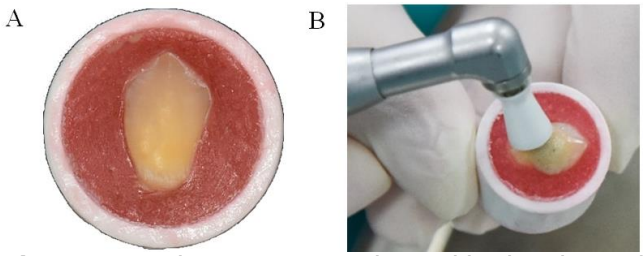

Figure 1. A human premolar with its buccal surface 1.0-1.5 mm above the plastic pipe's rim embedded and stabilized with self-curing acrylic resin in a plastic pipe (A), and recleaned with a pumice slurry (B).

After acid etching (Scotchbond Etchant; 3M ESPE, MN), water rinsing, air drying, and primer (Transbond XT; 3M Unitek, CA) application, a stainless steel bracket (3M Unitek) with an adhesive (Transbond PLUS color change adhesive; 3M Unitek) was placed on the middle 1/3 of each sample's buccal surface. The adhesive excesses were lightly removed with a dental explorer, followed by polymerization of the light-cured resin according to the manufacturers' instructions. After a storage in distilled water at 37ºC for 24 hours, they were thermocycled 500 times in each bath at 5-50ºC for 20 seconds and in interbath travel at 25ºC for 5-10 seconds, according to the International Standard Organization TB 11450 standard.

Postremovals of the brackets with peeling forces by bracket-removing pliers, remnant adhesives were assessed and scored by using a composite remnant index (CRI),[11] under a stereomicroscope (Olympus SZH10; Olympus, Tokyo, Japan) at a 25x magnification. Only those scored 4 (N = 71) from CRI were chosen and randomly divided into four groups according to the polishing methods as follows:

Group I (n = 18) polished by using a white stone bur (Figure 2A, Dura-White Stones; Shofu, Kyoto, Japan) attached to a high-speed handpiece (120,000 revolutions per minute; rpm) with water coolant and with a light force in a mesial-to-distal directed movement and pressing the bur's shank parallel to the tooth surface.

Group II (n = 17) polished by using a Sof-Lex disc (Figure 2B, Sof-Lex; 3M ESPE) attached to a low-speed handpiece (30,000 rpm) with air coolant and water irrigation during the polishing procedures in a sequence of course, medium, fine, and superfine discs with a light force in a mesial-to-distal directed movement and pressing the bur's shank parallel to the tooth surface.

Group III (n = 18) polished by using a tungsten carbide bur (Figure 2C, Renew adhesive removal burs #118S, Reliance Orthodontic Products, IL) in the same manner as those mentioned in Group I.

Group IV (n = 18) polished by using a sandblaster (Figure 2D, Micro-abrasive sandblaster; Parkell Inc, NY) with aluminum oxide powder (50-micron diameter) perpendicularly to the enamel surface at a distance of 10 millimeters, an air pressure of approximately 7 kg/cm^2.

Figure 2. A white stone bur (A), a Sof-Lex disc (B), a tungsten carbide bur (C), and a sandblaster (D) used for removing the orthodontic adhesive remnants from the tooth surfaces in this study.

The samples were rinsed by tap water and air-dried thoroughly using a moisture-free air source. A complete removal of all adhesive remnants from the enamel surfaces was carefully inspected by naked eyes combined with an LED light-cured machine, followed by a thorough reconfirmation with the stereomicroscope at a 25x magnification. Time consumption (seconds) for complete removal of the residuals from each sample was recorded.

The obtained data were analyzed using an SPSS program for Windows, Version 23.0)SPSS, NY). Descriptive statistics (mean ± standard deviations) were used to describe the time consumptions for removing the residuals. Differences among the removing methods were compared with a one-way analysis of variance (ANOVA), followed by Bonferroni's post hoc comparisons. The level of statistical significance was set at $P < 0.05$.

Results

The significantly least time consumption was detected in that using a tungsten carbide bur (18.80 ± 1.26 seconds), followed by those using a white stone bur (23.07 ± 2.95 seconds), a Sof-Lex disc (60.11 ± 4.34 seconds), and a sandblaster (86.82 ± 2.52 seconds), respectively (Table 1). In addition, intergroup significant differences ($P < 0.001$) in the time consumptions for adhesive removals were shown.

Groups (n)	Time consumption (seconds)
I, white stone bur (18)	23.07 ± 2.95 [a]
II, Sof-Lex disc (17)	60.11 ± 4.34 [b]
III, tungsten carbide bur (18)	18.80 ± 1.26 [c]
IV, sandblaster (18)	86.82 ± 2.52 [d]
P-value (one-way analysis of variance)	< 0.001

Table 1. Frequency of samples with each composite remnant score and time consumption (mean ± standard deviation) for removing the orthodontic adhesive materials in each group.
Different uppercase letters indicate significant differences at $P<0.05$.

Discussion

Human maxillary premolars were chosen for this experiment because they were commonly extracted to serve an orthodontic purpose. Since the enamel surface was focused in this work, any tooth undergone a fixed orthodontic treatment, a pre-existing damage, or a defect was excluded to decrease the confounding factors during assessing the surface.

After a bracket was removed by a bracket remover, a bond failure might occur at one of three interfaces, that is, adhesive-enamel interface, within the adhesive itself, or adhesive-bracket interface.[12] The last one resulted in the safest situation, due to a decrease in the risk of enamel cracking, when compared among them. However, it caused the largest amount of adhesives to be left on the tooth surfaces[13,14] and the longest time to clean up.[15,16] Out of 80 teeth in this study, 71 (88.75%) of them were scored 4 with CRI, indicating some adherences of a large amount of adhesives to the tooth surfaces. It illustrated that an optimal force for debonding by using such pliers was obtained with least, if any, enamel damage. In addition, an equitability could be assumed in case of our comparisons the adhesive remnant removal time among the different polishing methods.

A longer treatment time was unimpressive to any patient,[17] the durations of adhesive removals should be a critically important factor for considerations, even in an orthodontic treatment with satisfactory outcomes. Although sandblasting was suggested the method of removing residual adhesives that provided a smooth postpolished enamel surface,[8,10] some evidence of its time consumption was still unclear.[9] The complete removal of the adhesive remnants by using a tungsten carbide bur in this study consumed the significantly shortest time, when compared to those by a white stone bur, a Sof-Lex disc, and a sandblaster, respectively. This was consistent with those documented earlier.[9,17-19] With respect to the clinical time consumptions for a complete removal of postorthodontic residual adhesive, the tungsten carbide bur might cause the least chair time for patients with full-mouth bonded by fixed appliances.

Conclusions

Within the limitations of this in vitro study, a usage of a tungsten carbide bur to remove orthodontic adhesive remnants was concluded to consume significantly least time, when compared those using a white stone bur, a Sof-Lex Disc, and a sandblaster.

Acknowledgements

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Declaration of Interest

The authors declare no conflict of interest.

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