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Stereomicroscope Analysis of Enamel Surface after Orthodontic Bracket Debonding

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A B S T R A C T

After orthodontic brackets debonding, the remaining resin has to be removed. The purpose of this study was to determine the most efficient method as well as to introduce a new method of composite removal. The study was carried out on a sample of 30 premolars, extracted for orthodontic purposes. Brackets had been bonded using the Ortho One Bisco composite resin. After the removal of brackets, samples were randomly divided into three groups of ten. Composite remnants in the first group were removed using the Band Driver (KaVo). For the second group, the tungsten carbide bur (Komet) was applied. In the third group, composite remnants were removed manually, using adhesive removing pliers (ORMCO). The samples were analysed using a light-stereomicroscope (Olympus). Photomicrographs were examined and the ARI (Adhesive Remnant Index) was calculated. Post Hoc tests (Scheffe, Tukey) indicated a statistically significant difference between groups 1 and 2 as well as between groups 1 and 3. The tungsten carbide bur was found to be the most efficient instrument for composite remnant removal.

Key words: *remnant composite, enamel discoloration, composite removing methods*

Introduction

After orthodontic bracket debonding, there is a residual layer of composite left on the enamel surface that should be removed. Those composite remnants on the enamel surface are potential plaque traps. Environmental factors such as food or drinks could cause the aesthetic problem of tooth discoloration. A variety of methods for satisfactory composite remnant removal have been designed and investigated.

Based on the literature overview, Hong[1] divided the methods of composite remnant removal into three groups: hand

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instruments (e.g. pliers, scalers), rotary burs (e.g. diamond finishing burs, high speed and slow speed carbide burs) and ultrasonic devices (e.g. ultrasonic scaler).

Gwinett and Gorelick[2] suggested the use of a green rubber and polishing paste. Retief and Denys[3] proposed that scalers and diamond burs should not be used for composite remnant removal because they cause severe damages to the enamel surface. They suggested the use of the 12-blade tungsten carbide bur in compliance with an air coolant, followed by the application of polishing discs. Final polishing should be accomplished using paste applied by means of rubbers. Zachrisson and Artun[4] concluded that the low speed tungsten carbide bur is the best tool for composite removal. Rouleau, Grayson and Cooley[5] indicated that the use of the hand scaler was not desirable because it left deep gouges on the enamel, whereas the 12-blade tungsten carbide bur produced grooves. According to Rouleau, Grayson and Cooley[5], the ultra-fine tungsten carbide bur left a smooth enamel surface when used at high speed with water spray. Campbell[6] stated that good finishing techniques could produce a clinically acceptable appearance of the enamel surface. He did not assign special importance to instruments for residual composite removal.

The purpose of the study was to compare two already known and established methods of composite remnant removal (the tungsten carbide bur and pliers) with a new method (the Band Driver), based on quantitative analysis of enamel surface photomicrographs.

Material and methods

The sample of the study consisted of 30 premolar teeth extracted for orthodontic purposes. The selected teeth were intact and there were no evident enamel damages, fillings or carious lesions on the buccal surface. In order to prevent dehydration, the extracted teeth were stored in normal saline, at the temperature of 37 °C.

Buccal tooth surfaces were cleaned using brush and water to eliminate plaque and other organic material traps, which remained after the extraction.

Buccal surfaces were etched using 37 per cent orthophosphoric acid solution (E-mail Preparator blue, Etching gel, Ivoclar/Vivadent) for 30 seconds, washed in water and dried for 30 seconds. The brackets were bonded in the usual manner of everyday clinical practice, according to bonding agent manufacturer's instructions. The Ortho-One No-mix Orthodontic Primer, Bisco, and Ortho-One Selfcured Orthodontic Direct Bonding Paste from the same manufacturer were used. The Ultratrimm Edgewise metal brackets (Dentaurum) with the base surface of 10.3 mm^2 were used.

In order to achieve maximum bonding strength, teeth samples were left in normal saline at body temperature for 48 hours. Brackets were debonded using everyday clinical practice pliers (Narrow Direct Bond Removers w/Pad 800–0348, Ormco ETM). Finally, the samples were randomly divided into three groups, 10 teeth each.

For each group, one of the following 3 methods was applied:

- Method 1 – Band Driver (Kavo) with a tip for composite removal (Figure 1);
- Method 2 – Tungsten carbide bur (Komet) (Figure 2);
- Method 3 – Adhesive removing pliers (Ormco) (Figure3).

The Band Driver was used with a specially designed tip in the form of a flat chisel at 1,000 rpm.

The tungsten carbide bur was used at 150,000 rpm. Water spray was applied for surface cooling.

Fig. 1. Band Driver.

Fig. 2. Tungsten carbide bur.

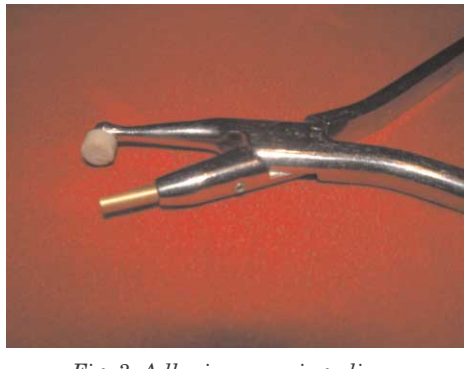

Fig. 3. Adhesive removing pliers.

Pliers were used according to manufacturer's instructions. A rubber tip was placed on the buccal cusp of a premolar tooth and the excessive composite was scrapped down from the tooth surface.

Cleaning time was limited to 15 seconds. Final polishing was conducted using a green rubber (Rocky Mountain, ECM 1047) and polishing paste (Mira-Clin P, Hager Werken).

Microscope and photomicrographs analysis

The used microscope was a binocular light-stereomicroscope Olympus SZX ZB 12 with a WHS30X-H ocular, a DFP LAPO1XPF lens and a Highlight 3100 light system for photomicrography. The camera was placed on the microscope and connected to a computer and a frame grabber of the same manufacturer. After cleaning the enamel surface, each sample was examined in the following two magnification modes:

- 50x for the entire buccal tooth surface;
- 200x for the four quadrants of the same surface.

After calibration, the photomicrographs were analysed using the Issa software package (VAMSTEC), equipped with the morphometric extension for planimetry (area measurement). Areas with composite remnants were marked and measured. Based on the results, the Adhesive Remnant Index (ARI)[7] was calculated (Table 1) according to the following formula: ARI = (area of residual resin / area of bracket base) x 100.

The analysis was conducted using SPSS (Statistical Package for Social Science) software, release 10.0. The following statistical methods were used:

- Standard descriptive statistics (Table 2);
- Analysis of variance – one way ANOVA;
- Post Hoc tests (Scheffe, Tukey).

Results

In the first group, the cleaning was carried out using the Band Driver (KaVo). On the sample no. 1 there was no resid-

TABLE 1
ADHESIVE REMNANT INDEX VALUES FOR EACH CLEANUP METHOD

Adhesive Remnant Index (ARI)			
Sample	Band Driver	Tungsten carbide bur	Adhesive removing pliers
1	0.000	0.000	0.000
2	0.003	0.000	0.004
3	0.005	0.000	0.011
4	0.012	0.014	0.003
5	0.027	0.000	0.000
6	0.090	0.000	0.031
7	0.200	0.000	0.004
8	0.236	0.000	0.004
9	0.301	0.000	0.019
10	0.309	0.000	0.009

TABLE 2
DESCRIPTIVE STATISTICS

Method	N	X	SD	Min.	Max.
1	10	0.1183	0.1295	0	0.31
2	10	0.0014	0.004427	0	0.01
3	10	0.0085	0.009767	0	0.03
Total	30	0.04273	0.09055	0	0.31

ual composite. The remaining samples indicated various amounts of composite remnants. Adhesive Remnant Index was higher for higher sample reference numbers.

The second group was cleaned using the tungsten carbide bur. Only one sample (no. 4) indicated composite remnants with the Adhesive Remnant Index of 1.4%.

In the third group, adhesive removing pliers were used for cleaning. The residual composite was indicated in 8 samples. ARI varies independently on the sample reference number. There was no indication of residual composite in samples no. 1 and no. 5.

Variance analysis (ANOVA) showed that there was a significant difference between all three methods ($p<0.01$). Post Hoc tests (Scheffe, Tukey) indicated a statistically significant difference between the following methods (Table 3):

- 1 and 2 ($p=0.005$);
- 1 and 3 ($p=0.008$).

Discussion

After bracket debonding, a specialist must fulfil high quality requirements considering restoration of the enamel to the condition it had prior to placing the orthodontic appliance.

Scanning electronic microscopy (SEM) is a method of the enamel surface investigation after bracket debonding and cleaning. This method has often been described in the literature. Many researchers conducted such studies, looking for the best method for residual composite re-

TABLE 3.
POST HOC TESTS (SCHEFFE, TUKEY)

	Method		Mean difference	p
Tukey HSD	1	2	0.1169	0.005
		3	0.1098	0.008
	2	1	–0.1169	0.005
		3	–0.0071	0.976
	3	1	–0.1098	0.008
		2	0.0071	0.976
Scheffe	1	2	0.1169	0.007
		3	0.1098	0.011
	2	1	–0.1169	0.007
		3	–0.0071	0.978
	3	1	–0.1098	0.011
		2	0.0071	0.978

moval[2,3,6]. SEM offers great possibilities for enamel surface investigation, providing high quality images with good depth sharpness[8–10]. However, disadvantages of this method should also be considered. Samples must be prepared prior to the microscopic investigation. Additionally, sample surfaces need to be steamed in order to make them conductible. A mixture of gold and palladium is most often used for this purpose.

Modern technologies offer new possibilities for hard tooth tissue surface investigations. In this study, an Olympus stereomicroscope was used. The quality of photomicrographs is satisfactory. It was possible to carry out microscopic investigations by a single person only. The method also did not require any preparatory work for enamel surface analysis.

In everyday clinical practice, specialists use their own procedures for enamel surface cleaning and polishing. Those procedures are usually based on their own personal experience, trials and error. Investigations show that specialists themselves are often not satisfied with the selected methods[11].

The method relying on the usage of specially designed pliers has already been described and recognised in literature[11]. The tungsten carbide bur method was investigated because, according to most studies, it is considered to be the best method for composite remnants removal. Some authors suggest the use of this bur at low speed[4]. Other authors propose its usage at high speed with water spray[5]. They recommend this approach as the technique which leaves the finest and the smoothest enamel surface with complete or almost complete removal of composite remnants.

The present study included two cleaning methods that had shown the best results in terms of simplicity, price and effectiveness. The resulting appearance of the enamel was not ideal, but it was acceptable[5,12].

The Band Driver (KaVo) is not primarily intended for this purpose. This instrument is commonly used for molar bands adaptation. In this study, a tip in the form of a chisel was used for removing the residual composite. The tip can be slightly rotated in its bearing, which is suitable for composite removal, because the chisel

is adapted to the form of the buccal tooth surface and the composite remnant. The results of this method have proved to be contradictory. The first sample had no residual composite while the composite amount on other samples indicated a progressive rise. This can be explained by the type of material the tip is made from. The tip managed to remove the residual composite with increased difficulty during the usage time. It was almost impossible to remove the resin from the last samples. The composite remnants that remained were even macroscopically visible. Due to the fact that for the first few samples the Band Driver left a completely smooth enamel surface without residual composite, this method can be ranked as a promising one. It is simple and fast, but it necessarily requires further investigation and improvement.

Among the 10 samples cleaned by means of a tungsten carbide bur, only one indicated composite remnants.

At first glance, the hand method of composite removal seemed acceptable because there were no macroscopically visible composite remnants on the enamel. However, areas of residual composite were revealed by microscope. The composite was removed completely from only 2 samples.

Comparing the results of the composite removal effectiveness, it is worth mentioning that there were statistically significant differences between the Band Driver and the tungsten carbide bur as well as between the Band Driver and the hand method. Compared to the other two methods, the Band Driver method ranked third, taking into account the limitations mentioned above. The hand method left remnants on 8 samples in small amounts, which ranked it second. The tungsten carbide bur ranked first because it removed all composite remnants from the 9 samples. Based on this finding, the priority is given to the use of the tungsten carbide bur in everyday clinical practice.

Conclusions

1. The tungsten carbide bur was found to be the most efficient instrument for composite remnant removal if used at high speed with a water coolant.

2. The Band Driver showed good results at the beginning, but the overall impression was poor because the tip soon became worn-out. With adequate improvement of the tip this method could become much better. This certainly requires further investigation.

3. None of investigated methods can be regarded as ideal, because each of them left composite remnants behind.

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STEREOMIKROSKOPSKA ANALIZA CAKLINSKE POVRŠINE NAKON SKIDANJA ORTODONTSKIH BRAVICA

S A Ž E T A K

Nakon skidanja ortodontskih bravica potrebno je ukloniti zaostatni kompozit. Svrha ovog istraživanja bila je utvrditi koja je metoda skidanja kompozita najbolja, te uvesti novu metodu. Istraživanje je provedeno na 30 premolara ekstrahiranih iz ortodontskih razloga. Bravice su ljepljene upotrebom kompozitnog materijala (Ortho One Bisco). Nakon skidanja bravica, uzorci su nasumično podijeljeni u tri skopine od po 10. Prva grupa čišćena je upotrebom Band Drivera (Kavo), druga upotrebom tungsten karbidnog svrdla (Komet), a treća ručno, kliještima za čišćenje adheziva (Ormco). Analiza uzoraka provedena je svjetlosnim stereomikroskopom (Olympus). Mjerenjem na mikrofotografijama izračunat je ARI (Adhesive Remnant Index). Post Hoc testovima (Scheffe, Tukey) utvrđena je statistički značajna razlika među grupama 1 i 2, te među grupama 1 i 3. Zaključeno je da je tungsten karbidno svrdlo najučinkovitije sredstvo u uklanjanju zaostatnog kompozita.

Ključne riječi: ostatni kompozit, diskoloracija cakline, metode uklanjanja kompozita