

ASSESSMENT OF ENAMEL SURFACE AFTER APPLICATION OF TUNGSTEN CARBIDE BUR FOR RESIDUAL ADHESIVE REMOVAL

Adriana Arbutina^{1}, Marijana Arapović Savić¹, Mirjana Umićević Davidović¹,
Vladan Mirjanić¹, Irena Kuzmanović Radman²*

¹University of Banja Luka, Faculty of Medicine, Division of Orthodontics,
Bulevar Petra Bojovića bb, 78 000 Banja Luka, Republic of Srpska

²University of Banja Luka, Faculty of Medicine, Division of Dental Diseases,
Bulevar Petra Bojovića bb, 78 000 Banja Luka, Republic of Srpska

Abstract: Introduction: Enamel damage often occurs in a process of adhesive removal after the completion of therapy with fixed orthodontic appliances. The aim of this study was to evaluate the enamel surface after applying a 12-fluted round tungsten carbide bur for adhesive removal at different speeds of dental micro motor after debonding brackets.

Material and method: On 40 human premolars, extracted for orthodontic purposes, metal brackets were bonded with composite material. After removing the brackets, the sample was divided into two groups: group A - 20 teeth from which the rest of the composite material was removed with a round tungsten carbide bur at 8,000 rotations per minute and group B - 20 teeth from which the rest of adhesive was removed with a round tungsten carbide bur at 32,000 rotations per minute. For each sample, four images were made under different magnifications by scanning electron microscopy, and the damage estimation was performed using the Enamel damage index (EDI) and Surface roughness index (SRI).

Results: The most common EDI score on the overall level was 3 (62.5%), while the most commonly represented SRI score was 2 (52.5%). There was no statistically significant difference in the average values of the EDI index ($t(38) = -.96, p > .05$) and in the average SRI index values ($t(38) = -.89, p > .05$) between two tooth examined groups.

Conclusion: Enamel damage was found after applying a round tungsten carbide bur at 8,000 and 32,000 rpm. The number of rotations per minute did not affect the size of enamel damage.

Keywords: Round tungsten carbide bur; Enamel damage index; Surface roughness index.

1. INTRODUCTION

After completion of orthodontic treatment with a multibracket appliance, it is necessary to remove the brackets and residual adhesive from each tooth. The highest risk of enamel loss exists at the moment of bracket debonding with an appropriate instrument, but enamel damage most commonly occurs in the process of adhesive removal [1-5].

Rotary instruments are widely used to remove the adhesive remnants. Among them, tungsten carbide burs are the most frequently used for this purpose. The working part of the tungsten carbide bur consists of special tungsten-carbide steel, which is characterized by hardness and it is used for work in dentine, enamel and for removing metal fillings. In

larger number of blades are used to remove adhesive from a tooth surface. The burs with 12 or more blades are also used for final processing of dentine and enamel, and the burs with 30 blades are used for polishing. The most commonly procedure in practice after debonding brackets is the use of a 12-fluted fissure tungsten carbide bur and round end for avoiding mechanical gingival injuries [6,7].

Beside the use of fissure tungsten carbide burs in orthodontic practice, a tungsten carbide bur with a round shape of working part is also used after completed therapy with fixed orthodontic appliances for initially remnants removal. 8-fluted burs are the most commonly used, in which one of the main blade is made by joining two auxiliary blades. The auxiliary blades reduce the vibration of the main blade. To remove the remaining adhesive in ortho-

* Corresponding author: adriana.arbutina@med.unibl.org

dontic practice, larger diameter burs with larger number of blades (12 or 30) are frequently used and with adequate polishing after their application [6].

These burs are used to initially remove a larger amount of residual adhesive, which provides complete adhesive removal from a tooth surface in a short period, but there is a high possibility of damaging an enamel surface. It is very important to choose an adequate rotation speed of dental micro motor and to use cooling due to less chance of causing damage to the enamel and thermal changes in a pulp area. By increasing the number of rotations of micro motor per minute, the temperature in a working area increases, so any increase above 5.5 °C causes inflammatory changes in the pulp area, where some of them are irreversible [8-10].

The qualitative evaluation of enamel damage is most commonly performed by applying appropriate indexes on images at different magnifications, such as the Enamel damage index (EDI) and Surface roughness index (SRI). The EDI was introduced in research by Schuler and Van Vaes in 2003, and SRI was introduced by Howell and Weeks in 1990 [9,10].

The aim of the present study was to estimate the surface damage of human premolars after application of a 12-fluted round tungsten carbide bur at 8,000 rpm and the same bur at 32,000 rpm for adhesive removal after completion the therapy with fixed orthodontic appliances.

2. MATERIAL AND METHOD

In this study, 40 human premolars extracted for orthodontic purposes, were collected. The collected sample fulfilled a research criterion: an intact buccal and oral teeth surface, without micro fractures, caries lesions, and that the teeth had not previously been exposed to chemical agents. This was confirmed by stereomicroscopy (10x magnification). The sample was stored until the beginning of the study in physiological solution, which was changed once a week to slow down the development of bacteria and to prevent enamel dehydration. The buccal surface of each tooth was conditioned with 38% orthophosphoric acid for 20 seconds and then washed with air-water spray for 30 seconds. Aspire orthodontic adhesive 7GM (OC Orthodontics, USA) was applied on the buccal surface of 40 teeth and then polymerized for 10 seconds [13]. The metal brackets (Ortho Organizer Elite OptiMIM, Henry Schein® Orthodontics, USA) were bonded using Aspire Orthodontic Adhesive 5GM (OC Orthodontics, USA) on the prepared tooth surface. The polymerization was carried out with a LED lamp

according to the manufacturer's instructions for 40 seconds. The sample was left for 48 hours in Biotene gel (which served as a source of artificial saliva), so the adhesive system could reach its maximum bonding strength. After 48 hours, the brackets were debonded with bracket removing pliers. After debonding brackets, the adhesive remnants were removed with a 12-fluted round tungsten carbide (Komet, Lemgo, Germany) (Figure 1). According to the number of rotations per minute of dental micro motor in a process of remaining adhesive removal, the sample was divided into two groups:

Group A - 20 teeth from which the rest of the adhesive was removed with a 12-fluted round tungsten carbide at 8,000 rotations per minute,

Group B - 20 teeth from which the rest of the adhesive was removed with a 12-fluted round tungsten carbide bur at 32,000 rotations per minute.

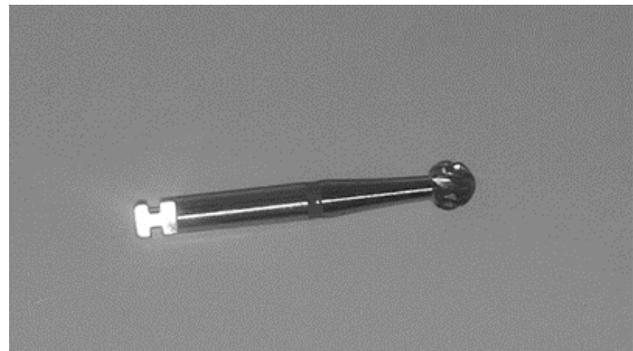


Figure 1. 12-fluted round tungsten carbide bur

Placing and removing the brackets and the process of adhesive removal were carried out by one researcher (AA) [14]. After residual adhesive removal, the sample was prepared for scanning electron microscopy (SEM). For each sample, four images were obtained, at 15x, 100x, 500x and 1 500x magnification (Figures 2 and 3). Qualitative assessment of enamel damage was carried out by applying the Enamel damage index on SEM images by one examiner (MAS), three times in a seven-day interval, according to the following scale:

score 0 – a smooth surface without enamel damage,

score 1 – an acceptable surface of the enamel with several scratches,

score 2 – a rough surface of the enamel, numerous scars and smaller recesses and

score 3 - a surface without straight scratches, wide recesses and surface damages that are visible to the naked eye [11].

The SRI index is determined according to the following scale:

score 1 – an acceptable area of the enamel, a few scratches,

score 2 – a rough surface, a few scratches, some of them deeper,
score 3 – a rough surface, a large number of scratches over the entire surface and
score 4 – a very rough surface, large number of deep scratches on the whole surface [12]. The

examiner did not know to which group images belonged, while estimating them. The average value of the three estimations was taken as an appropriate EDI score for each sample [15].

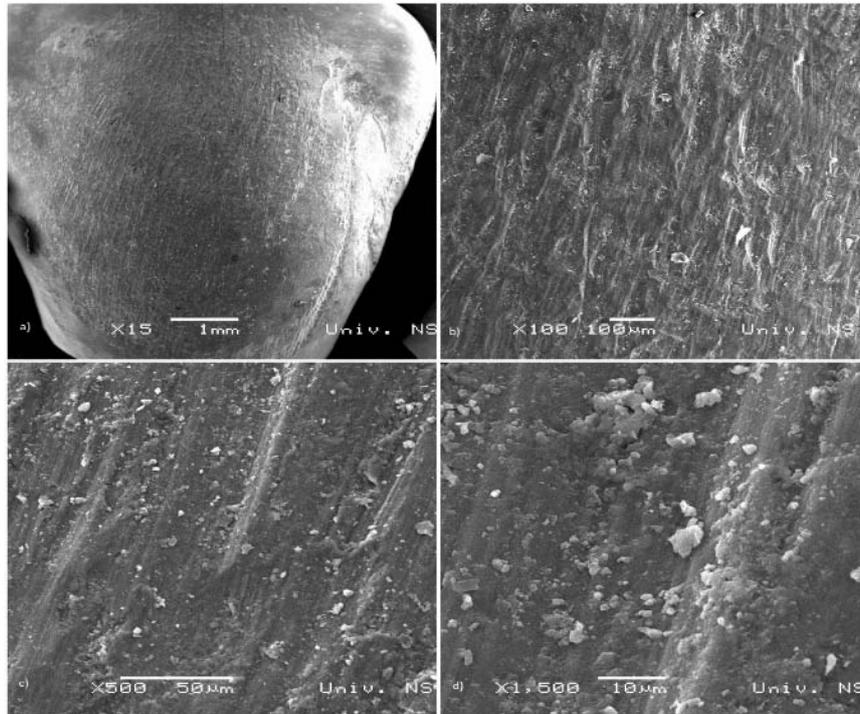


Figure 2. SEM images of enamel damage cause by a round tungsten carbide bur at 8 000 rpm under different magnifications a)15x, b)100x, c)500x and d)1 500x

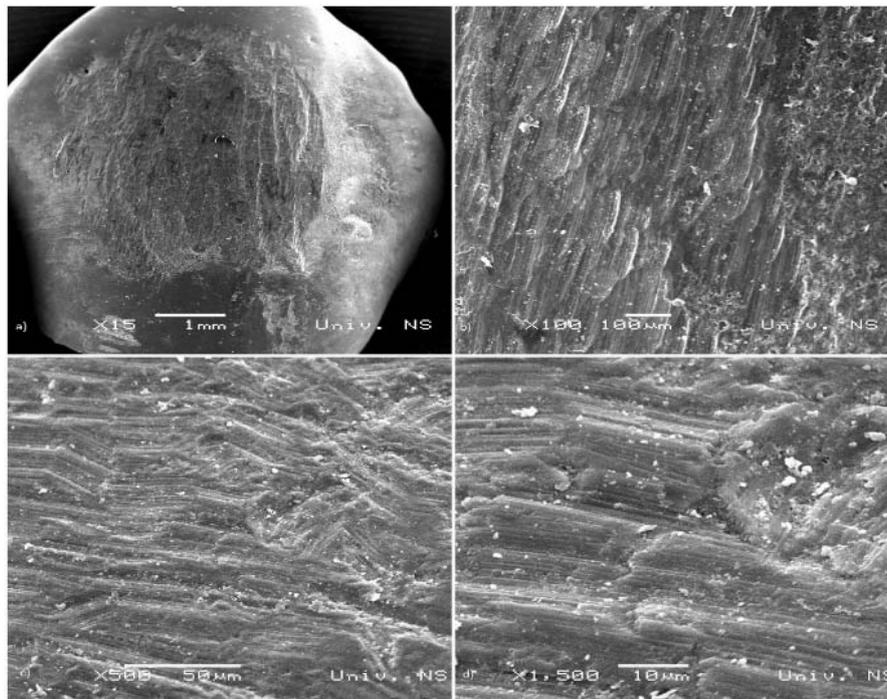


Figure 3. SEM images of enamel damage cause by round tungsten carbide bur at 32 000 rpm under different magnifications a)15x, b)100x, c)500x and d)1 500x

2.1. Statistical data analysis

Qualitative data (EDI scores and SRI scores) are shown by a number of occurrences and percentages. The Student t test was used to compare the mean values of the EDI and SRI. The statistical significance was set at $p < 0.05$.

3. RESULTS

Table 1 shows the distribution of EDI scores per groups. The most common EDI score on the overall level was 3. Even for 25 teeth (62.5%), a score of 3 after removal of the adhesive with a tungsten carbide bur was determined, for 11 teeth (55%)

in group A (at 8,000 rpm) and 14 teeth in group B (at 32,000 rpm). A score of 0 and score of 1 were not determined. A large number of teeth from group A had a score of 2 (9 teeth, or 45%), while in group B only 6 teeth (30%) had that score.

Table 2 shows the distribution of SRI scores by groups. The most common SRI score on the overall level was a score of 2. Even for 21 teeth (52.5%), the score of 2 was determined after the removal of adhesive with a tungsten carbide bur, for 12 teeth from group A (at 8,000 rpm) and 9 teeth from group B (at 32,000 rpm). A score of 1 was not assigned to any teeth, 6 teeth from group A had a score of 3 (30%), and only 2 (10%) teeth had a score of 4. In group B, a score of 3 was determined for 8 teeth (40%), and a score of 4 for 3 teeth (30%).

Table 1. Distribution of EDI scores

Round tungsten carbide bur (number of rotations)	EDI score				Total
	0	1	2	3	
8 000 rpm*	0 (0%)	0 (0%)	9 (45%)	11 (55%)	20 (100%)
32 000 rpm*	0 (0%)	0 (0%)	6 (30%)	14 (70%)	20 (100%)
Total	0 (0%)	0 (0%)	15 (37.5%)	25 (62.5%)	40 (100%)

*rotations per minute

Table 2. Distribution of SRI scores

Group	Round tungsten carbide bur (number of rotations)	SRI score				Total
		1	2	3	4	
A	8 000 rpm*	0 (0%)	12 (60%)	6 (30%)	2 (10%)	20 (100%)
B	32 000 rpm*	0 (0%)	9 (45%)	8 (40%)	3 (15%)	20 (100%)
	Total	0 (0%)	21 (52.5%)	14 (35%)	5 (12.5%)	40 (100%)

*rotations per minute

Tables 3 and 4 show the average values of the EDI score and SRI score after applying a round tungsten carbide bur at 8,000 and 32,000 rpm. With the Student t test, statistically significant differences were not determined in the average values of the EDI score between the two groups in which the residual adhesi-

ve was removed at different speeds of the micro motor ($t(38) = - .96, p > .05$) (Table 3). In addition, statistically significant differences in the average values of SRI scores, depending on the number of rpm applied during the adhesive removal, were not determined using the same test ($t(38) = - .89, p > .05$).

Table 3. Descriptive statistics and Student t test for EDI scores

Rotations/min	N	M	SD	T	df	p
8 000	20	2.55	.51	-.96	38	.34
32 000	20	2.70	.47			

Table 4. Descriptive statistics and Student t test for SRI scores

Rotations/min	N	M	SD	t	df	p
8 000	20	2.50	.69	-.89	38	.38
32 000	20	2.70	.73			

4. DISCUSSION

After debonding metal brackets, enamel damage was observed after applying a 12-fluted round tungsten carbide bur, regardless of the speed of dental micro motor. However, a slightly higher number of scores 3 of the EDI was determined at its application at higher speed of dental micro motor. A round bur is not recommended for removing adhesive close to the surface of enamel, but it can still be used for initial adhesive removal within a multistep technique. For this purpose, a fissure tungsten carbide bur is used more frequently, due to the shape of the work piece itself which in a contact with a labial surface of tooth leaves no deeper grooves and scratches on the enamel.

Pus and Way investigated the loss of enamel due to the application of various methods for removing the remaining adhesive on 100 premolars, extracted for orthodontic purposes, after debonding metal brackets using the Nikon Profile Projector. With four tooth groups, the remnants of adhesives were removed by different methods: adhesive removing pliers, a tungsten carbide bur at high speed, a tungsten carbide bur at low speed and a green rubber followed by sandblasting. The mean enamel loss value was $29.8\mu\text{m} + (-) 4.79\mu\text{m}$. The smallest loss of enamel was determined after the application of a tungsten carbide bur at low-speed, suggesting that the number of rotations per minute of dental micro motor during the removal of adhesive can affect the damage and loss of enamel [16]. Although this study did not determine a statistically significant difference between the two groups of teeth, greater damage was found on the teeth from which adhesive was removed by a carbide bur with a higher number of rotations per minute of micro motor.

Before placing orthodontic brackets, it is necessary to prepare the surface of enamel by conditioning with an appropriate etching system, creating a zone of demineralization in the surface layer of enamel and it is expected that damage will occur after removal of the brackets [17-19]. However, this damage must be minimized [20-22]. Vieira at al. conducted their study on nine teeth to investigate the surface of enamel by removing the adhesive with a tungsten carbide bur without polishing, with polishing the enamel with rubber cups for 10 seconds and polishing with rubber cups for 30 seconds. They found that even after polishing for 30 seconds, the area of enamel was not the same as that of a control group with a fully intact enamel surface [23]. This result is in a line with the results of the present study.

Palmer at al. compared the influence of the Er:YAG laser at 200 mJ and 20 Hz, Er:YAG laser at 305 mJ and 10 Hz, a 5-fluted round end tapered fine diamond bur at high speed, a 8-fluted round tungsten carbide bur at low speed and a 20-fluted flame shaped tungsten carbide bur to the tooth surface after removing metal brackets and residual adhesive. Quantitative and qualitative estimations presented that the greatest damage was caused after the laser application, and indicated that after the application of a fissure tungsten carbide bur, the surface of enamel was smooth, while the round bur caused deep scratches on the surface of the tooth itself [24].

Ryf at al. compared five different tooth-polishing techniques after removing the rest of the composite material by a tungsten-carbide bur, concluded that there were no significant differences among the polishing techniques. Their research was carried out on 75 extracted human molars. They recommended the use of appropriate dental surface polishing systems with a carbide bur to achieve a satisfactory appearance of enamel surface which can extend the time of removing the fixed orthodontic appliances [25].

Cardoso at al. conducted a study on 50 human premolars, extracted for orthodontic purposes. They examined the following five methods for removing adhesive after completed orthodontic therapy: a tungsten carbide bur, a Sof-lex disc, a composite bur, adhesive removing pliers and an ultrasonic scaler. The metal brackets were bonded with Transbond XT composite material, and, after 24 hours, they were debonded by debonding pliers. After the application of adhesive removal method, the enamel surface was visualized by stereomicroscope (40x and 100x magnification). They found that each of the applied methods led to changes in the enamel surface. The least damage on the enamel surface was found after the application of abrasive discs followed by a composite bur, a tungsten carbide bur and adhesive removing pliers. The use of an ultrasonic scaler did not prove to be an effective method for removing adhesive from a tooth surface. The authors have proposed the use of discs and composite bur as an optimal protocol for removing the adhesive [26].

This study had some limitations like the small sample size and lack of quantitative evaluation. Moreover, only one method was examined. Further studies should consider quantitative evaluation of more than one method for adhesive removal, for providing information about enamel loss and increasing sample size.

5. CONCLUSION

From this pilot study, the following can be concluded:

After removing the composite material from the tooth surface, enamel damage was determined after the application of a round tungsten carbide bur, both at 8,000 rotations per minute and at 32, 000 rotations per minute.

6. ACKNOWLEDGMENTS

This research is part of a pilot study conducted within PhD thesis of Adriana Arbutina. In this pilot study, the optimum number of rotations of the micro motor was determined for rotary instruments used for adhesive removal, after completion of therapy with multibracket appliance.

7. REFERENCES

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ПРОЦЈЕНА ПОВРШИНЕ ГЛЕЂИ НАКОН УКЛАЊАЊА ОСТАТКА АДХЕЗИВА ТУНГСТЕН-КАРБИДНИМ СВРДЛОМ

Сажетак: Увод: приликом уклањања адхезива по завршеној терапији фиксним ортодонским апаратима често долази до оштећења глеђи зуба. Циљ овог рада је био да се процијени оштећење површине глеђи након примјене округлог тунгстен-карбидног сврдла са 12 сјечива за уклањање адхезива при различитом броју обртаја микромотора у минути након уклањања металних ортодонских бравица.

Материјал и метод рада: На 40 хуманих премолара, екстрахованих у ортодонске сврхе, лијеplене су металне бравице композитним материјалом. Након уклањања бравица, узорак је подијељен у двије групе: група А – 20 зуба са којих је остатак композитног материјала уклоњен са округлим тунгстен-карбидним сврдлом при 8.000 обртаја микромотора у минути и група Б – 20 зуба са којих је остатак адхезива уклоњен истим сврдлом, али при 32 000 обртаја микромотора у минути. На фотомикрографијама извршена је процјена оштећења глеђи примјеном Индекса оштећења глеђи (Enamel damage index-EDI) и Индекса храпавости површине глеђи (Surface roughness index-SRI).

Резултати: Најчешће заступљена EDI оцјена на укупном нивоу је била оцјена 3 (62,5%), док је најчешће заступљена SRI оцјена на укупном нивоу била оцјена 2 (52,5%). Није утврђена статистички значајна разлика у просјечним вриједностима EDI индекса ($t(38) = -0,96, p > 0,05$) и просјечним вриједностима SRI индекса ($t(38) = -0,89, p > 0,05$) између двије групе зуба код којих је остатак адхезива уклањан различитим брзинама обртаја микромотора у минути.

Закључак: Оштећење глеђи је утврђено након примјене округлог тунгстен-карбидног сврдла при 8.000 и 32.000 обртаја микромотора у минути. Број обртаја микромотора у минути није имао утицаја на величину насталих оштећења.

Кључне ријечи: округло тунгстен-карбидно сврдло; индекс оштећења глеђи; индекс храпавости површине глеђи.

