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ORIGINAL RESEARCH

Enamel Surface Roughness after Debonding: A Comparative Study using Three Different Burs

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ABSTRACT

Aim: To compare effects of three different burs, i.e., tungsten carbide bur, composite bur, and fiber glass bur on the surface roughness of enamel after debonding evaluated by means of profilometry.

Materials and methods: The present study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Guru Nanak Dev Dental College and Research Institute, Sunam, Punjab, India, from August 2011 to December 2012 on 36 extracted premolars. After mounting the samples in acrylic blocks with their buccal surfaces exposed, initial measurement of the surface roughness was made using profilometry. Teeth were then etched and brackets were bonded with light cure adhesive. After 3 days, the brackets were debonded using three different rotating burs at low speed, i.e., tungsten carbide bur, fiber glass bur, and composite bur. Enamel surface roughness values were obtained and assessed using paired t-test, one-way analysis of variance (ANOVA) test, and *post hoc* multiple tests.

Results: Surface roughness of enamel increased significantly for tungsten carbide bur when compared with fiber glass bur and composite bur. But there was no significant difference in the surface roughness value when fiber glass bur was compared with the composite bur.

Conclusion: Composite and fiber glass burs used for resin removal after orthodontic debonding produced a smoother enamel surface as compared with the tungsten carbide bur.

Clinical significance: After an orthodontic treatment, restoring the enamel surface to its pretreatment condition without inducing any iatrogenic damage after debonding is a clinical challenge. Residual resin removal through proper means ensures a smooth surface, and, hence, a plaque-free environment. Finishing requires as much planning and execution as planned for the fixed therapy itself.

Keywords: Bracket debonding composite bur, Fiber glass bur, Orthodontic procedures, Tungsten carbide bur.

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INTRODUCTION

Esthetics has been a vital constituent for centuries in human life. Eliminating esthetic problems aids in boosting self-confidence of one's personality. The most common reason for an individual seeking orthodontic care is to improve the appearance of teeth, thus improving their esthetics. Direct bonding has been widely accepted by orthodontists as it enhances ability for plaque removal, thus decreases soft tissue irritation and hyperplastic gingivitis. Moreover, it provides a more esthetic orthodontic appliance to the patient.[1]

With recent advances in the physical and mechanical properties of bonding materials, cleanup of resin leftovers after debonding of orthodontic bracket, keeping in mind the integrity of enamel, has become a clinical challenge.[1] If these leftover particles of resin are not completely removed, it may lead to unesthetically discolored tooth surface.[2] Moreover, mechanical removal of remaining remnants of composite can cause prominent areas or grooves on the tooth surface leading to enamel staining and plaque accumulation, which in turn may cause enamel demineralization. Even though the occurrence of scarring on the enamel surface appears to be inevitable after adhesive removal, the damage can be abridged to a minimum level by adopting a proper technique.[3]

The search for an efficient and safe method being introduced has led to different techniques being introduced for resin removal, which includes abrading with a scaler or by a plier used for band removing, removal with tungsten carbide bur or a diamond bur, air abrasion technique, ultrasonic application, rubber tips, etc.[4-6] Continuous advent of new debonding materials and methods, such as air flow, different types of burs, Sof-Lex disks, ultrasonic devices, and lasers are carried out to obtain minimal iatrogenic damage.[7] Macieski et al[8] suggested that use of carbide bur in low-rotation for removal of resin leftovers, and use of rubber tips for polishing of enamel followed by polishing paste causes less damage to the enamel.

The most popular method for debonding in orthodontic clinics is to use burs. Type of bur is an important factor to be taken into consideration while working without any damage on the enamel surface. Other instruments of choice include polishing disks and polishing paste or pumice. However, various techniques result in dissimilar polishing degrees, scratches and abrasions incidence, and results in consequent enamel surface damage.[7]

The present *in vitro* study was carried to compare and evaluate the effects of three different burs, i.e., tungsten carbide bur, fiber glass bur, and composite bur on the surface roughness of enamel after debonding using profilometry.

MATERIALS AND METHODS

This *in vitro* study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Guru Nanak Dev Dental College and Research Institute, Sunam, Punjab, India, from the period of August 2011 to December 2012 on 36 extracted maxillary and mandibular premolars obtained from patients undergoing therapeutic extractions prior to orthodontic treatment. Ethical clearance was obtained from the institutional committee of the institute and informed consent was obtained from patients. Only morphologically well-defined teeth with no caries, fractures, or any restorations were included in the study.

The sample size was calculated using the Epi Info 6 computer package by the statistician. Teeth were mounted in self-cure resin blocks with the buccal surfaces exposed. Coronal part of the exposed surface was polished using a low-speed handpiece and the total sample was then stored in distilled water. Sample was randomly divided into three equal groups of 12 teeth each and color coded. Initial measurements of the surface roughness of enamel were taken at this time using profilometry machine and recorded.

Systematic bonding of the coronal tooth surface and the metal bracket was done under ideal conditions. Care was taken to ensure proper etching,[9] application of primer, application of adhesive, uniformity in bracket seating, and ideal curing protocol. The procedure was followed for all 36 mounted teeth which were stored in distilled water to allow resin to reach its maximum strength.

After 3 days, metal brackets were debonded using a posterior debonding plier. Resin removal was done with three different types of burs, i.e., tungsten carbide bur, fiber glass bur, and composite bur (Fig. 1) in a low-speed handpiece with water cooling. They were grouped into group I (green color)—resin removal with tungsten carbide bur, group II (brown color)—resin removal with fiber glass bur, and group III (blue color)—resin removal with composite bur (Fig. 2).

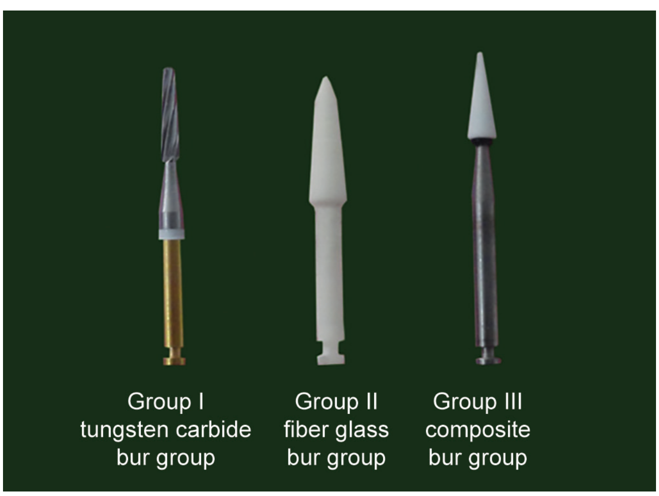
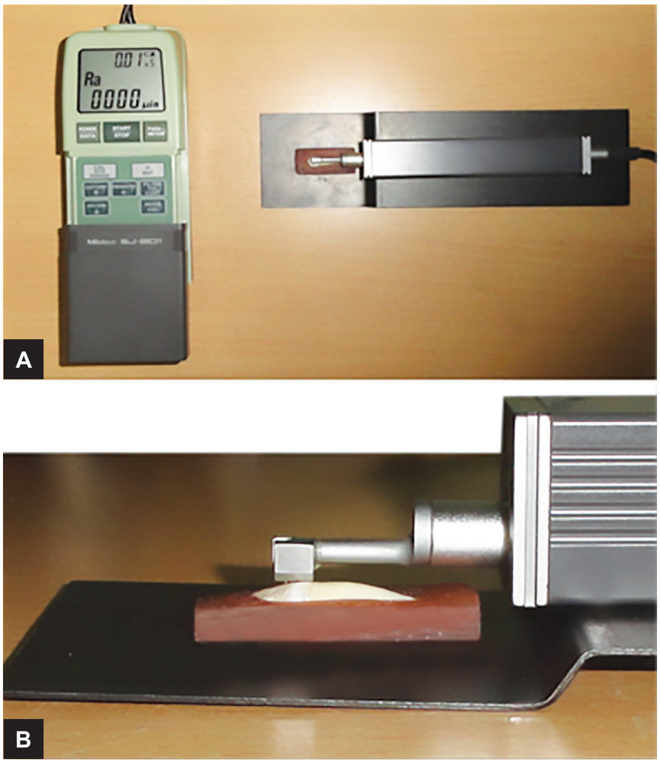


Fig. 1: Finishing burs

Fig. 2: Color-coded acrylic blocks



Figs 3A and B: Profilometry machine to evaluate surface roughness: (A) surface profilometry, (B) stylus tip of surface

A new bur was used for each tooth. Complete removal of the resin adhesive was verified by visual inspection under a dental operating light under dry conditions.

After cleanup procedure, mounted teeth were subjected to surface roughness evaluation using a surface profilometry machine (Fig. 3).

Statistical Analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences version 14.0 software (SPSS Inc., Chicago, Illinois, USA). Average roughness value (Ra) signifies the overall surface roughness. It is the arithmetic mean of all absolute distances of the roughness profile from the center line within the measuring length. Root mean square roughness value (Rz) represents the average maximum peak to valley height of five successive sampling lengths within the measuring length. It should be used for direct clinical observation and describes the degree of roughness of the surface.[7]

The values of enamel surface roughness obtained were tabulated and analyzed using paired t-test, one-way ANOVA test, and Bonferroni *post hoc* multiple test. Pairwise comparison between the means was carried using Bonferroni *post hoc* test when ANOVA test was significant. The level of significance was set at $p \leq 0.05$.

RESULTS

One-way ANOVA test was applied using SPSS 14 to determine if significant differences existed between the enamel surface roughness values of three different groups under consideration. Table 1 compares the prebond surface roughness values and after resin removal surface roughness values for three different types of burs used. It was seen that tungsten carbide bur significantly increased the surface roughness of enamel. Fiber glass bur and composite bur, on the contrary, significantly decreased the surface roughness of enamel.

Table 2 compares the prebond root mean square roughness values and after resin removal root mean square roughness values for the three different types of burs used. Similar to the above observation, tungsten carbide bur increased the surface roughness of enamel significantly, whereas fiber glass bur and composite bur significantly decreased the surface roughness of enamel.

Intercomparing within the same groups using *post hoc* tests in tungsten carbide bur group (group I), Ra and Rz values before bonding when compared with Ra and Rz values, respectively, after resin removal showed highly significant difference. This suggested that tungsten carbide bur significantly increased the surface roughness of enamel as compared with the surface roughness of enamel before bonding (Table 3).

In fiber glass bur group (group II), Ra and Rz values before bonding when compared with respective Ra and Rz values after resin removal showed significant differences. This suggested that use of fiber glass bur

Table 1: Comparison of surface roughness values (Ra)* using one-way ANOVA test

Group	*n*	*Prebond Ra (average roughness value) (μm inches)*	*After resin removal Ra (average roughness value) (μm inches)*
I (Tungsten carbide bur)	12	20.55 ± 2.6	34.00 ± 2.7
II (Fiber glass bur)	12	21.87 ± 2.9	17.62 ± 2.0
III (Composite bur)	12	22.28 ± 2.4	14.80 ± 2.7

*Ra refers to average roughness value that represents the overall surface roughness and can be defined as the arithmetic mean of all absolute distances of the roughness profile from the center line within the measuring length[7]

Table 2: Comparison of surface roughness values (Rz)* using one-way ANOVA test

Group	*n*	*Prebond Rz (μm inches) mean ± SD*	*After resin removal Rz (μm inches) mean ± SD*
I (Tungsten carbide bur)	12	82.11 ± 4.45	132.25 ± 3.90
II (Fiber glass bur)	12	73.43 ± 2.86	42.97 ± 2.48
III (Composite bur)	12	77.47 ± 3.95	41.10 ± 2.54

*Root mean square roughness value (Rz) can be defined as the average maximum peak to valley height of five consecutive sampling lengths within the measuring length and is used to describe the degree of roughness of the surface of sample and should be used for direct clinical observation[7]

Table 3: Comparison of surface roughness values within same groups using paired samples t-test

Group	*Surface roughness*	*p-value*
I (Tungsten carbide bur)*	Prebond Ra—after resin removal Ra	0
	Prebond Rz—after resin removal Rz	0
II (Fiber glass bur)*	Prebond Ra—after resin removal Ra	0
	Prebond Rz—after resin removal Rz	0
III (Composite bur)*	Prebond Ra—after resin removal Ra	0
	Prebond Rz—after resin removal Rz	0

*p ≤ 0.05 refers to significant value; **Ra is average roughness value and Rz is root mean square roughness value

significantly decreased the surface roughness of enamel as compared with surface roughness of enamel before bonding (Table 3).

In composite bur group (group III), Ra and Rz values before bonding when compared with the respective Ra and Rz values after resin removal showed significant differences, which suggested that the use of composite bur significantly decreased the surface roughness of enamel as compared with surface roughness of enamel before bonding (Table 3).

When surface roughness values (Ra and Rz) after resin removal for the three bur groups were compared, results obtained were nonsignificant when Ra values of fiber glass bur group and composite bur group were compared. Similarly, on comparing the Rz values after resin removal, no significant differences were found on comparing fiber glass bur group and composite bur group (Table 4).

Table 4: Comparison of surface roughness values of different groups using *post hoc* tests

Roughness values after resin removal	*Study groups*		*p-value*
Ra value	I (Tungsten carbide bur)	II	0
		III	0
	II (Fiber glass bur)	I	0
		III	0.07
	III (Composite bur)	I	0
		II	0.07
Rz value	I (Tungsten carbide bur)	II	0
		III	0
	II (Fiber glass bur)	I	0
		III	0.07
	III (Composite bur)	I	0
		II	0.07

$p < 0.05$ significant

DISCUSSION

Development of dental materials, mainly resin composite as well as adhesive systems, has led to better enamel and resin adhesion, decreasing bracket bonding failure rate for those undergoing orthodontic treatment.[10] However, removal of residual resin after bracket debonding has become more difficult due to this better enamel and resin adhesion. Depending on the method used for debonding, cracks can be produced on enamel. Therefore, the method used for residual resin removal is very important to determine any damage to enamel, such as cracks, increased roughness of enamel, excessive enamel wear,[11] and overheating of the tooth and pulpal necrosis.[12] The rotatory instruments provide a smaller surface roughness of the enamel structure in comparison with methods, such as erbium-doped yttrium aluminum garnet laser. Moreover, in cases when ultrafine diamond bur is used, enamel does not return to its original integrity, indicating irreversible damage.[6] Furthermore, changes in enamel surface caused due to bracket debonding are crucial as damage to the enamel surface further decreases enamel resistance and hence, increases chances of decalcification.[13]

The time should not be considered as factor of choice for the method employed since preserving the original appearance of the enamel surface is important.[6] Various methods are available to measure enamel surface roughness after resin removal: Visual inspection by photography, scanning electron microscopy, and adhesive remnant index.[14-16] Some studies have examined enamel loss by comparing weights or by using a planer surfometer.[17] However, most of them did not compare enamel surface textures as it is more difficult to analyze the nonflat surfaces.[18] For compensating this limitation, we used a profilometer for profilometric analysis in the present study.

No statistically significant difference in surface roughness was noted between the three groups before bonding. Ra and Rz were the parameters employed in our study to check the surface roughness. Many studies have employed Ra as the sole indicator of surface texture.[19] To improve the description of surface profile, additional parameter, i.e., Rz was introduced.

In the present study, the bracket from the enamel surface was removed by applying force to the bracket in a manner to break the bracket–resin interface by leaving the resin remnants on the enamel surface. It is significant in case when orthodontic attachments are bonded to the enamel by using a heavy filled resin, as the mechanical retention is provided by microporosities formed by etching which are packed with resin.[20]

Resin removal from tooth surfaces after debonding was done with three different types of burs, i.e., tungsten carbide bur (group I), fiber glass bur (group II), and composite bur (group III). Literature is controversial about the most effective method for removal of residual resin. Diedrich[14] in his study stated deep enamel fractures to a depth of 100 m and localized enamel loss of 150 to 160 m, Ryf et al[21] reported a mean loss of enamel of 7.9 m with tungsten carbide bur. Zarrinnia et al[22] showed mean loss of enamel of about 19.2 m when tungsten carbide bur was operated at high speed, but enamel loss was 11.3 m when used at low speed. Retief and Denys[23] recommended use of tungsten carbide bur at high speed with sufficient air cooling, whereas Rouleau et al[24] suggested water spray in place of air cooling for heat control. Zarrinnia et al[22] suggested that tungsten carbide burs with air coolant operated at high speed are effective in residual resin removal.

Newer and more conservative burs have been designed for enamel surface. A composite bur was designed initially to softly remove cement, colored coatings, and stains from the enamel surface. It has also been advocated for use in orthodontics for clean-up procedures after debonding.[25]

In the oral cavity, bacterial plaque has a tendency to adhere to the hard surfaces (tooth, prosthesis, filling material, or implant) if they are rough. Reduction in surface roughness will lead to a remarkable decrease in plaque formation and maturation. According to our study, in the composite bur (group III) and fiber glass bur (group II), roughness values obtained after finishing procedures were lower than initial values. Finishing with a composite bur and fiber glass bur created a much smoother surface than was seen in the initial stage prior to bonding and thereby may reduce the occurrence of bacterial colonization. Similar results were found by Trakyali et al[26] who reported that composite bur may eliminate surface roughness and can make better the light reflection of enamel.

Difference in the cutting efficiency of the three instruments employed in our study can be determined by a number of parameters like the bur rotation speed, pressure applied to the handpiece during cutting, type of bur used, and the flow rate of coolant through the handpiece at the bur/tooth cutting interface.

CONCLUSION

Finishing of enamel surface following debonding marks the end of the fixed orthodontic therapy and beginning of a new phase for the patient. If leftovers of resin are not completely removed, or we can say that the surface is not smooth, then tooth surface can probably become unesthetically discolored, resulting in plaque accumulation with time.

Although fiber glass bur and composite bur provide better results, they are time-consuming procedures. Thus, to reduce the duration of resin removal, adhesive remnants can first be abraded with a tungsten carbide bur followed by the composite bur or fiber glass bur for removal of the last adhesive layer. Thus, our results suggest that after orthodontic debonding, the fiber glass bur (group II) and the composite bur (group III) used for resin removal created smoother surfaces compared with the tungsten carbide bur (group I), even smoother than original surfaces.

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