Enamel surfaces after orthodontic bracket debonding

Phillip M. Campbell, DDS, MSD

Composite bonding of orthodontic attachments to enamel surfaces has had a significant, if not revolutionary, impact on clinical orthodontic treatment. Comfort to the patient, conservation of arch length, and ease and accuracy of placement are but a few of the advantages. Although the advantages of bonding clearly outweigh the disadvantages, some concerns remain. The primary consideration lies in returning the enamel surface to as near its original state as possible following removal of bonded orthodontic attachments.

The purpose of this paper is to evaluate these concerns and to present a practical and efficient clinical method of returning enamel to as near its original condition as possible following removal of bonded orthodontic attachments.

The bonding of orthodontic brackets for the purpose of aligning teeth is a widely accepted and universally used treatment modality. Introduction of the acid-etch technique[1] for bonding orthodontic attachments has proven to be a landmark advancement in clinical orthodontic treatment and the literature is replete with related reports.[2-7]

Conversely, there has been a paucity of information related to the effects of debonding on enamel surfaces. Most clinicians have developed their own armamentarium of debonding and polishing, basing their methods on trial and error. Gwinnett and Gorelick[8] pointed out that many of the practiced and recommended modalities being used were harmful to the enamel surface. Their scanning electron microscope study provided insight into the enamel scarring that inevitably occurs at debonding. They also evaluated the different methods of polishing enamel and concluded that polish-

Abstract

The enamel surfaces of extracted teeth were studied clinically and with a scanning electron microscope following debonding of orthodontic attachments and subsequent polishing. Excess orthodontic resin was removed with tungsten carbide burs and abrasive discs. Several combinations of polishing agents were evaluated.

The no. 30 fluted tungsten carbide bur appeared to be the most efficient method of removing highly filled resin, and it produced the least amount of scarring. A polishing sequence was developed which used resin points and cups followed by a water slurry of fine pumice and brown and green cups.

This procedure was tested clinically and appeared to return the enamel to an acceptable condition. This procedure is fast, efficient, and comfortable for the patient.

Key words

Enamel surfaces • Scarred enamel • Post-debonding polishing

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Figure 1A-B
Two examples of untouched enamel.

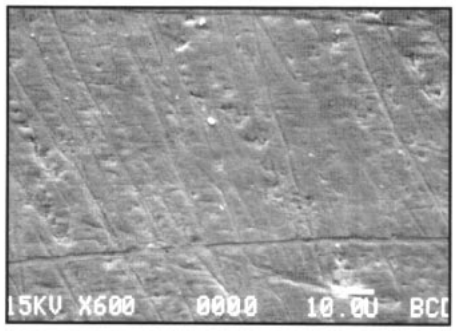

Figure 1A

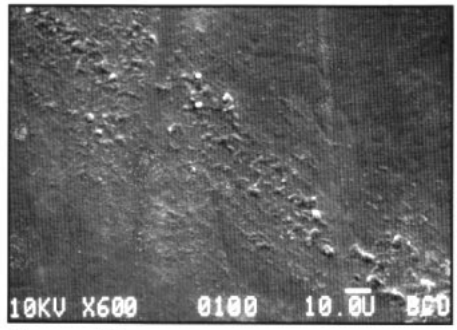

Figure 1B

ing with a green rubber wheel followed by pumice or composite finishing paste came closest to restoring the enamel surface to its original quality.

Retief and Denys[9] described the removal of direct bonded attachments and the finishing of underlying enamel as an acute clinical problem. Using the scanning electron microscope they concluded that debonding pliers, scalers, and diamond finishing burs should not be used to remove the remaining resin after debonding because they cause deep gouges in the enamel. They recommended using a 12-bladed tungsten carbide bur at high speed with adequate air cooling to remove the bulk resin, finishing the residual resin and underlying enamel with graded polishing discs or ceramiste wheels with light pressure and adequate air cooling, and final finishing with a water slurry of pumice applied with a rubber cup.

Zachrisson and Artun[10] employed the replicating stereomicroscope and the scanning electron microscope to evaluate the quality of enamel surfaces following debonding of orthodontic brackets. They used both extracted teeth and a replicating technique to evaluate enamel surfaces and concluded that a tungsten carbide bur at low speed produced the finest scratch pattern and the least enamel loss.

Rouleau, Grayson and Cooley[11] used a replicating technique to study postdebonded enamel surfaces. Eleven raters used scanning electron photomicrographs to rank the apparent smoothness of enamel surfaces. They suggested that the hand scaler is not desirable for removal of resins because it produces deep gouges, and although the 12-fluted bur was effective in resin removal, it produced fine scratches and facets on the enamel surface. They concluded that the instrument leaving the smoothest enamel surface was the tungsten carbide ultrafine bur operated at high speed with water spray.

It is quite clear from a perusal of the literature that a variety of opinions exist concerning methods of resin removal and the subsequent enamel polishing. In reevaluating these techniques, it is incumbent upon the clinician to select the modalities which return the enamel surface to as near its original condition as possible with the least amount of enamel scarring and loss. The clinical appearance of the enamel, even when dry, should be pleasing.

Survey

A simple survey consisting of five questions was mailed to 72 clinical orthodontists who were members of the Southwest Component of the Edward H. Angle Society or the Charles H. Tweed Study Group of Texas. Sixty-two surveys were returned representing a response rate of 86.1%

The survey and results were as follows:

Question #1. Do you ever experience problems with scarred enamel after debonding? What percentage of cases? Over 80% of the respondents recognize enamel scarring following debonding whereas 19% see no change. Only 12% acknowledge scarring in over half of their cases.

Question #2. What is your method of removing brackets? Approximately 55% of the clinicians use a ligature cutter or band slitting plier.

Question #3. What is your method of removing bonding material from enamel surfaces after debonding? The remaining composite is removed with a fluted bur by 45% of the operators, while a scraping instrument is used by 32%.

Question #4. What is your method of polishing enamel upon removal of the above? Polishing methods are quite varied, with 32% using pumice, 21% using sandpaper discs, and 18% using rubber wheels. Many clinicians prefer a combination of these modalities.

Question #5. Do you feel virgin enamel is more esthetically pleasing than enamel which has had an orthodontic bracket affixed? Virgin enamel is more pleasing to 52% of the respondents, while 47% feel that the appearance of enamel that has been bonded is as good.

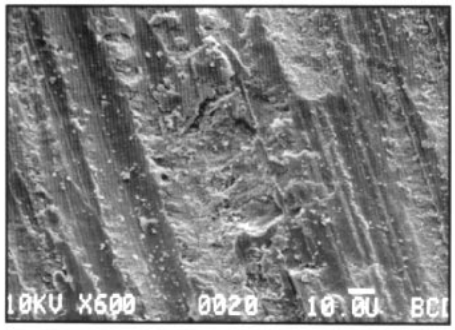

Figure 2

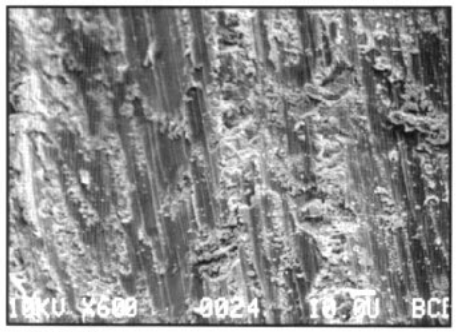

Figure 3

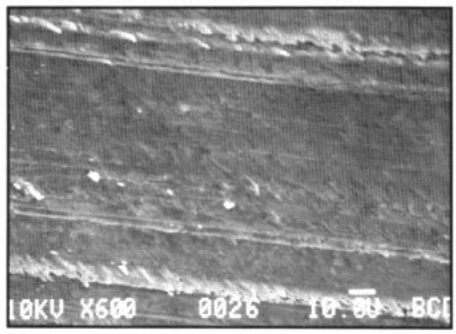

Figure 4

Materials and methods

Maxillary central incisors, lateral incisors, and canines that had been removed because of periodontal involvement were collected from area dentists and stored in 10% formalin. The teeth were rinsed in water and any remaining tissue fragments were removed from the root surfaces. The apices were embedded in plaster to facilitate identification and manipulation.

The labial surfaces of the teeth were acid etched with a 37% phosphoric acid gel for 15 seconds, then rinsed with distilled water and dried with an air syringe. Sealant (Maxicure, Reliance Orthodontic Products, Inc., Itasca, Ill) was then applied. Twin brackets were bonded using a highly filled resin bonding material (Phase II, Reliance Orthodontic Products, Inc., Itasca, Ill).

A pilot study was conducted which included six methods of gross resin removal. The teeth were randomly divided into six groups: 1) greenstone, 2) diamond, 3) sharp band remover, 4) no. 30 fluted bur, 5) crosscut bur, and 6) abrasive discs (Soflex, Dental Products/3M, St. Paul, Minn). After preliminary screening, the first three groups were dropped from the study. The brackets were removed from the remaining three samples using an anterior band-slitting plier (#1026, ETM Corporation, Monrovia, Calif) with a peeling action. Two tungsten carbide burs (Sample A—No. 30 Fluted Bur, #246LUF012, and Sample B—Crosscut Bur, #283FQ010, both Brasseler, Savannah, Ga) were used to remove the bulk of the resin and an attempt was made not to touch the adjacent enamel. Coarse abrasive discs were also used in the third category for bulk resin removal (Sample C). A plaque-disclosing solution or food coloring was used to stain the remaining resin pad to enhance visibility. Loupes (5X) were worn to provide magnification of the operating field.

The teeth in each of the samples were then polished using a variety of abrasive components.

1) Enhance points and cups (Caulk/Dentsply, Milford, Del). These shapes are made of a solidified resin filled with aluminum oxide and glycerine and are molded onto plastic latch type mandrels. They are disposable.

2) Fine pumice.

3) Restore (Reliance Orthodontic Products, Inc., Itasca, Ill). A polishing paste designed for polishing porcelain, composite, gold, and amalgam (composed of distilled water, sodium salts of coconut, boric acid, tetra sodium, salt of EDTA, glycerine, and diatomaceous earth).

4) Brown and green cups (Brasseler, Savannah, Ga). These silicone polishing cups are filled with aluminum oxide and molded onto metal latch-type mandrels. The brown cup has a larger particle size than the green.

A clinically acceptable final lustre was achieved in all samples following each complete series of polishing steps.

The samples were photographed before and after the various procedures. The specimens were then mounted on aluminum stubs and sputter coated with approximately 15 to 20 nanometers of a gold palladium mixture. Photomicrographs were made at a magnification of X600 using a JEOL JSM 35CF scanning electron microscope operated at 10 or 15 KV.

Following a careful evaluation of the results of the laboratory procedures using the scanning electron photomicrographs, a sequence of polishing procedures was established clinically. Intraoral photographs (35 mm slides) were made during the various stages of the polishing sequence.

Results

Two controls of untouched enamel are presented in Figure 1A and B. There is a wide range of variability in the microscopic appearance of enamel surfaces. The scanning electron photomicrographs of enamel surfaces using various methods of removing the bulk of resin are shown as follows: greenstone, Figure 2; finishing diamond, Figure 3; and sharp band remover, Figure 4. The scanning electron photomicrographs of the no. 30 fluted bur, crosscut bur, and coarse

Figure 2
Enamel surface after removal of resin with greenstone.

Figure 3
Enamel surface after removal of resin with finishing diamond.

Figure 4
Enamel surface after removal of resin with sharp band remover.

Table 1
Sample A - Resin removal with 30 fluted tungsten carbide bur (#246LUF012)

Bur Back & forth	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
SEM 0014	SEM 0013	E Point & Cup	E Point & Cup	E Point & Cup	E Point & Cup	E Point & Cup	Coarse SL Disc	Medium SL Disc	Medium SL Disc	E Point	E Cup/ Restore	E Cup/ F pumice
		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
		SEM 0015	Fine Pumice	Restore	Fine Pumice	Restore	Med SL Disc	Fine SL Disc	E Cup	E Cup/ Restore	Green Cup	Green Cup
			↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
			SEM 0018	SEM 0012	Red/Grn Cups	Red/Grn Cups	Fine SL Disc	Superfine SL Disc	Restore	Superfine SL Disc	SEM 0007	SEM 0045
					↓	↓	↓	↓	↓	↓		
					SEM 0010	SEM 001"	Superfine SL Disc	SEM 0006	Green Cup	SEM 0027		
							↓		↓			
							SEM 0005		SEM 0008			

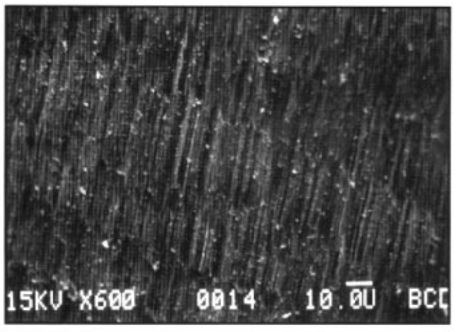

Figure 5A

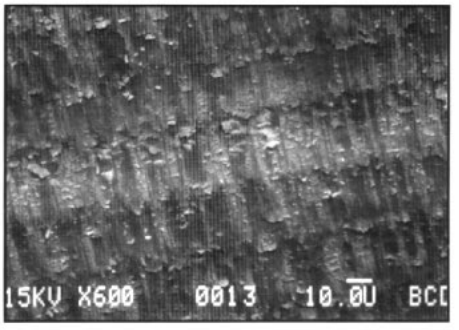

Figure 5B

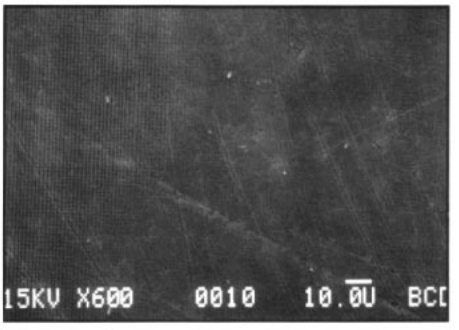

Figure 5C

Figure 5A-C
A: After resin removal with a no. 30 fluted bur using a back-and-forth motion.
B: After resin removal with a no. 30 fluted bur using a careful brush stroke.
C: After resin removal with a no. 30 fluted bur, Enhance point and cup, fine pumice, and brown and green cup.

Soflex disc will be shown in later sequences. All modalities removed the bonding resin effectively, and obvious scarring occurred in all specimens.

The greenstone, diamond finishing bur, and sharp band remover were eliminated as methods of resin removal due to the severe scarring, which was visible clinically and in the scanning electron photomicrographs. The coarse Soflex disc, crosscut bur, and no. 30 fluted bur provided smoother surfaces clinically and, during experimentation, were judged acceptable for bulk resin removal. All specimens were polished to a clinically acceptable end result with various combinations of available abrasives.

The no. 30 fluted bur (Table 1—Sample A)

This tungsten carbide bur removed the excess resin easily and appeared to produce the least amount of scarring clinically. Figure 5A shows the scarring that occurred when a back-and-forth motion was used and all resin was removed. The vertical scars show a consistent, small pattern. Figure 5B shows the enamel surface after the same bur was used with a brush stroke to remove the bulk of the resin. Because this bur appeared to cause the least amount of scarring microscopically, more combinations of polishing agents were used with this sample in an attempt to find the most efficient sequence.

Figure 5C shows the results of polishing with the Enhance point and cup followed by fine pumice, then the brown and green cups. This enamel surface appears to be the smoothest microscopically and is certainly acceptable clinically.

Fine fluted crosscut tungsten carbide bur (Table 2, Sample B)

This tungsten carbide bur removed the remaining resin efficiently but left a grid-like pattern of scarring with both vertical and hori-

Table 2
Sample B–Resin removal with fine fluted crosscut tungsten carbide bur

Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke	Bur Brush stroke
↓	↓	↓	↓	↓
Sem 0041	E Point & Cup	E Point & Cup	E Point & Cup	E Cup/fine pumice
	↓	↓	↓	↓
	SEM 0042	Fine pumice	Fine pumice	Green cup
		↓	↓	
		SEM 0043	Green cup	SEM 0040
			↓	
			SEM 0044	

Table 3
Sample C–Resin removal with coarse Soflex disc

Coarse SL disc	Coarse SL disc	Coarse SL disc	Coarse SL disc
↓	↓	↓	↓
Sem 0001	Medium SL disc	Medium SL disc	Medium SL disc
	↓	↓	↓
	SEM 0021	Fine SL disc	Fine SL disc
		↓	↓
		SEM 0019	Superfine SL disc
			↓
			SEM 0003

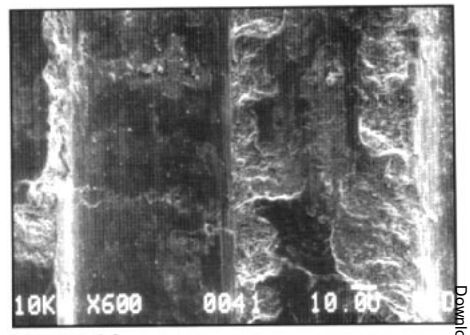

Figure 6A

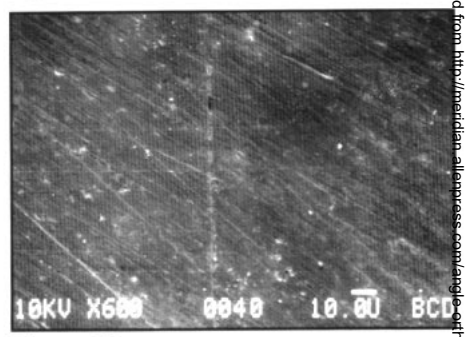

Figure 6B

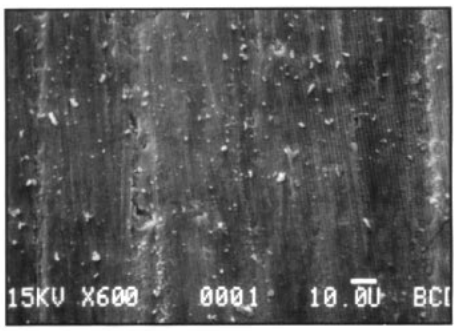

Figure 7A

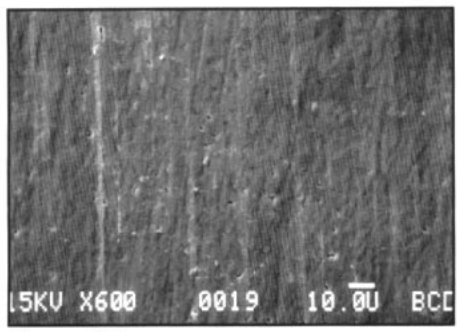

Figure 7B

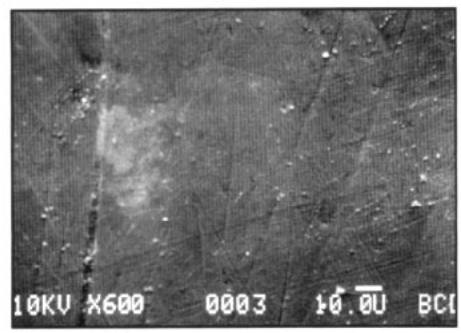

Figure 7C

zontal scratches in the enamel surface. Figure 6A shows the scarring which occurred with this bur used with a careful brush stroke. Figure 6B shows the enamel surface after use of the Enhance cup with fine pumice and a green cup. The clinical appearance is good but microscopic scarring remains.

Coarse Soflex discs (Table 3, Sample C)

Coarse Soflex discs removed the excess resin efficiently but were quite cumbersome. Figure 7A shows the scarring that occurred with the coarse disc, which does not appear as severe as the scarring that occured with the crosscut bur. Figure 7B shows the enamel surface after the use of coarse, medium, and fine Soflex discs. This surface appears acceptable both clinically and microscopically. Figure 7C shows the enamel surface after using the coarse, medium, fine, and superfine Soflex discs. The clinical appearance of the enamel surface is good but microscopically, irregular scratches are visible.

All of the polishing agents used were effective in reducing the scarring which inevitably occurs during resin removal. Enhance points and cups efficiently removed gross scarring. Restore paste seemed acceptable clinically, but obvious fine scratches were visible in the photomicrographs. Fine pumice appeared to provide the smoothest surfaces both clinically and microscopically. The Soflex discs also produced acceptable surfaces clinically but showed small scratches microscopically. The brown and green cups provided an excellent final polish clinically and microscopically.

Discussion

Some enamel scarring following the removal of bonded brackets is inevitable. Regardless of the competence of the clinician or the instruments used, some scarring will occur in every case. Fortunately, most scarring can be removed with a series of abrasives, hopefully

Figure 6A-B
A: Fine fluted crosscut tungsten carbide bur with careful brush stroke.
B: Fine fluted crosscut tungsten carbide bur, Enhance cup, fine pumice, and green cup.

Figure 7A-C
A: Coarse Soflex disc.
B: Coarse, medium, and fine Soflex discs.
C: Coarse, medium, fine, and superfine Soflex discs.

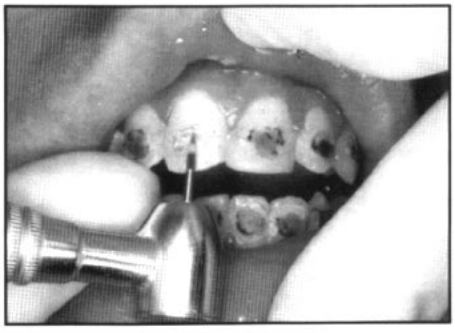

Figure 8A

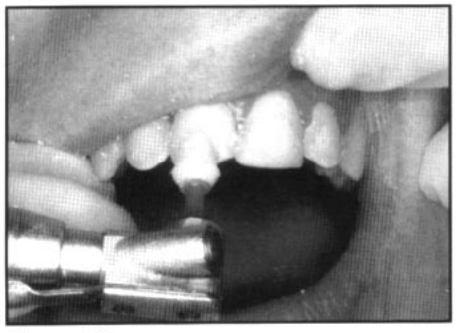

Figure 8B

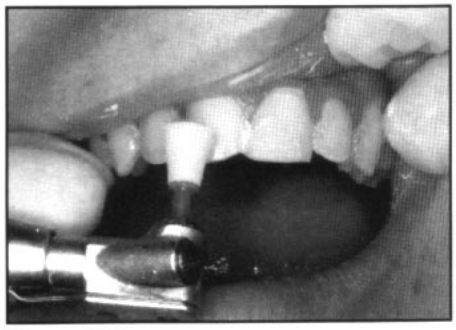

Figure 8C

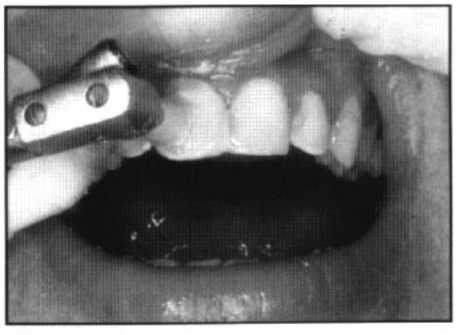

Figure 8D

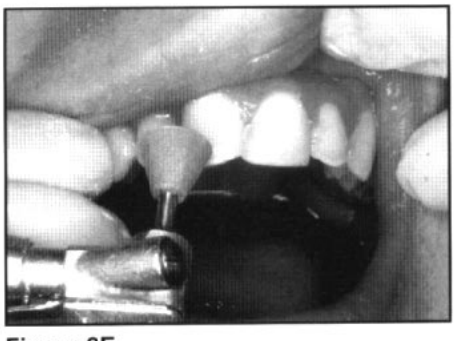

Figure 8E

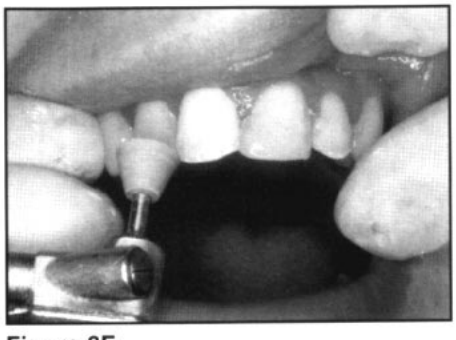

Figure 8F

Figure 8A-F
The complete polishing sequence:
A: Resin removal with no. 30 fluted bur;
B: Polishing with Enhance point;
C: Polishing with Enhance cup;
D: Polishing with Enhance cup and fine pumice;
E: Polishing with a brown cup;
F: Polishing with a green cup.

without harming the pupal tissues and with minimal loss of enamel.

In the present survey, most clinicians (80%) recognized some scarring of enamel after debonding, although only half felt that virgin enamel was more esthetically pleasing. The remaining orthodontists surveyed were apparently satisfied with their polishing techniques.

Postdebonding scarring of enamel is a disadvantage of orthodontic bonding. However, there is no debate that the advantages of bonding outweigh the disadvantages. The clinician, therefore, must accept enamel scarring as a given and then methodically attempt to return the enamel surface to as near its original condition as possible.

An acceptable clinical appearance of enamel can usually be achieved with good polishing techniques, regardless of the instruments used to remove the bonding resin. The obvious concern is to minimize damage to the pulpal tissues and to prevent excess enamel loss.

The intent of this paper is not to criticize any technique or product but to emphasize the need for recognizing the problem and to attempt to provide the most efficient and least damaging armamentarium for resolving it. Further study is needed to develop products which will make this procedure even more efficient and safe.

For now, fine fluted tungsten carbide burs used at high speed with a careful and light brush stroke in one direction appear to be the fastest, most efficient, and least damaging method of removing the remaining bonding material when orthodontic brackets are removed. Discs and rubber wheels, although effective, may be cumbersome for some clinicians and may produce excess heat, which could be damaging. Greenstones, finishing diamond burs, and scraping instruments (sharp

Resin removal and enamal polishing steps

1. **Use a no. 30 fluted tungsten carbide bur at high speed to remove the bulk of the remaining resin.**
2. **Use Enhance points and cups to remove gross scarring.**
3. **Follow with a water slurry of fine pumice to provide a smooth surface prior to final polish.**
4. **Finish with brown and green cups (dry) to produce a final highly glossed clinical appearance.**

Figure 9A

Figure 9B

Figure 9A-B
A: Enamel surface before treatment.
B: After treatment and polishing.

debonding pliers, scalers, etc.) certainly remove the bonding resin, but may cause deeper scars and gouges than tungsten carbide burs and result in greater enamel loss.

Enhance points and cups proved effective in removing the gross scarring caused by burs or discs. These molded shapes contain aluminum oxide and glycerin and seem to produce less heat than comparable products. Medium and fine Soflex discs were also effective in removing gross scars but appeared to be slightly cumbersome to manipulate and produced microscopic scratches.

A water slurry of fine pumice appeared to be most efficient in providing a smooth surface prior to final polishing. A porcelain polishing paste (Restore) was also effective clinically but showed some scratches microscopically, which possibly were due to the presence of diatomaceous earth particles.

The brown (coarse) and green (fine) rubber cups provided a clinically pleasing, highly shined enamel surface. These cups are filled with aluminum oxide and produce a glossy enamel surface when the teeth are dry.

In a busy clinical practice, postdebonding polishing must be effective, efficient and comfortable for the patient. This can be accomplished in four simple steps, as follows:

1) No. 30 fluted tungsten carbide bur (#246LUF012) at high speed.
   - Carefully move the bur in one direction when removing the resin layers and avoid touching the enamel adjacent to the resin pad.
   - Apply food coloring or disclosing solution to the resin pad to improve visibility.
2) Enhance points and cups
   - Use to remove gross scarring.
   - The points are especially useful in deep developmental grooves.
3) Water slurry of fine pumice
   - The pumice can be applied with a prophy cup but is usually used with the Enhance cup to improve efficiency.
4) Brown and green cup (dry)
   - Use the coarser brown cup first.
   - Follow with the fine green cup to produce a final gloss

Figure 8A-F shows the complete polishing sequence. Figure 9A shows the pretreatment condition of the enamel and Figure 9B shows the enamel after debonding and polishing treatment.

The purpose of the present paper is twofold: 1) to emphasize the need to recognize that postdebonding scarring of enamel does occur, and 2) to provide an efficient method of returning the enamel surface to an acceptable clinical appearance when the teeth are dry. Admittedly, most teeth appear acceptable when bathed in saliva, but when dried, defects, when present, are obvious. As ethical clinicians, we should aspire to please the patient, the referring dentist, but mainly ourselves and our profession, and to "Do no harm."

Conclusions

1) The scarring of enamel following the removal of bonded brackets is inevitable.

2) Scarred enamel should be polished without damaging the pulpal tissues and with minimal loss of enamel.

3) Use a specific polishing sequence, as described, to produce an esthetically pleasing enamel surface.

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