JCO-Online Copyright 2003 - VOLUME 33 : NUMBER 05 : PAGES (286-292) 1999

SEM Evaluation of a New Technique for Interdental Stripping

M. ZHONG, DDS
P.G. JOST-BRINKMANN, DDS, PHD
R.J. RADLANSKI, DDS, PHD
R.R. MIETHKE, DDS, PHD

Stripping (interproximal enamel reduction) is commonly used to resolve tooth-size discrepancies between the left and right sides or between the maxillary and mandibular arches.1 It is also an alternative to premolar extractions and arch expansion in patients with mild to moderate crowding.2-4 Some orthodontists use stripping to improve stability or to reshape the morphology of the teeth for esthetic reasons.5-7

Based on the findings of in vitro scanning electron microscopic (SEM) investigations, a number of authors have recommended evaluation of the oral hygiene and caries potential of each patient before stripping.8,9 Radlanski and colleagues reported that diamond-coated burs and coarse metal strips used for gross reduction of proximal surfaces of premolars in vivo caused irreversible scratches on the enamel surfaces, resulting in a significant increase in plaque accumulation.10 Nevertheless, they observed only a low incidence of caries in treated areas. Clinicians differ in their opinions on how to achieve perfectly smooth surfaces. Hand-held or motor-driven abrasive strips and handpiecemounted abrasive disks or burs are most commonly used.3-5 Few authors have suggested methods to avoid damage to the gingivae and other soft tissues.5,11

The purpose of this SEM investigation was to evaluate the morphologic effects of different enamel stripping techniques–especially of a new perforated diamond-coated disk in an oscillating handpiece--and of various polishing procedures.

Materials and Methods

Twenty-four extracted human teeth (12 incisors and 12 premolars) were selected according to the following criteria:

1. No obvious loss of tooth material or demineralization on the mesial or distal proximal surfaces.

2. No restorations on any surfaces.

3. No enamel cracks on the proximal surfaces.

The teeth were randomly assigned to four groups, each containing three subgroups of two incisors and two premolars.

The samples were stored in .1% thymol before and after removal of the attached soft tissue from the root surfaces. The teeth were then mounted in Frasaco model bases, and each model was mounted in a phantom head to simulate clinical conditions. Before and after stripping, the mesiodistal diameter of each tooth was measured with a sliding digital caliper.

Premolar enamel was reduced by .5mm per surface, and incisor enamel by .3mm. The enamel reduction was performed with a diamond-coated bur at 4,000-6,000 rpm and a perforated diamond-coated disk in either a conventional contra-angle handpiece or an oscillating handpiece.

The latter has the advantage that it will not injure the soft tissues when operated at speed setting 4 of the Sirona S motor (Fig. 1).

The ground enamel surfaces were polished with Sof-Lex XT fine and ultrafine disks (Fig. 2) at 200-400 rpm, three tungsten carbide burs (Fig. 3), or fine and ultrafine oscillating Elastrips at 4,000-6,000 rpm (Fig. 4), all with adequate water spray.

In three of the groups, the polishing time for each step was 40 seconds; in the fourth group, each instrument was applied for only 20 seconds (Table 1).

Replicas were made for SEM evaluation of each sample after stripping and again after polishing. Organic surface debris was removed with 5% hypochloride, and the tooth was then rinsed with distilled water and dried with compressed air. Impressions were taken with an injection-type vinyl polysiloxane material, rinsed with alcohol, poured with epoxy resin, and sputter-coated with gold for two minutes at 25 mA. A 20kV scanning electron microscope was used at various magnifications to compare the effects of the different stripping and polishing methods with untreated enamel surfaces (Fig. 5).

Results

Enamel surfaces were rougher after stripping with the diamond-coated bur than after disking (Figs. 6 and 7). Surfaces polished by the rotating instruments were smoother than those treated with Elastrips (Figs. 8, 9, 10, and 11). In all cases, the enamel roughness produced by stripping was almost totally eliminated by using the fine and ultrafine Sof-Lex XT disks for 40 seconds each (Figs. 8 and 9).

The surface gloss appeared to increase with polishing time (Fig. 11), and the polished surfaces were smoother than untreated enamel.

Discussion

Studies by Piacentini and Sfondrini12 and Puigdollers13 have shown that the deep furrows produced by coarse diamond-coated strips could not be eliminated by polishing, and that they promoted the adherence of bacteria and thus increased the risk of caries. Radlanski and colleagues found that "artificially produced furrows were still clearly visible" one year after enamel reduction.14 We therefore feel it is of the utmost importance to polish to the smoothest possible surface after stripping. In the current study, grinding with a diamond-coated bur or disk caused extensive enamel roughness, making subsequent finishing and polishing mandatory.13,15

A combined mechanical and chemical technique, as advocated by Joseph and colleagues, appears unnecessary.16 Although these authors suggested the application of fluoride solutions after stripping, etched enamel is susceptible to demineralization and rapid plaque accumulation, which could result in greater exposure to carious agents. Sheridan and LeDoux proposed the application of a sealant,17 but this raises questions such as how long the sealant would remain, what condition the enamel would be in once the sealant had dissipated, how a dry working field could be achieved next to the gingiva, and how contact could be avoided between the gingiva and a potentially cytotoxic sealant.18

Radlanski and colleagues found enamel surfaces with deep scratches after polishing with hand-held Sof-Lex strips that were moved back and forth 20 times.10 On the other hand, Hein and Jost-Brinkmann demonstrated smooth surfaces after 60 seconds of polishing with Sof-Lex disks or strips in a motor-driven handpiece.15 In this study, we found that the surfaces treated for 40 seconds with rotating polishing instruments were smoother than those polished by the Elastrips. It may be possible to achieve better results with Elastrips by increasing the polishing time, but this is not an attractive approach as long as more efficient alternatives are available.

Hein and Jost-Brinkmann showed that polishing with three Sof-Lex disks (medium, fine, and ultrafine) produced surfaces smoother than untreated enamel.15 In the present study, the furrows from stripping were almost totally eliminated by only two Sof-Lex XT disks (fine and ultrafine) operated at 200-400 rpm for 40 seconds each. Even the steps and waves produced by grinding with a diamond-coated bur were found to be well polished. A new set of disks should be used for every tooth, however, because the surface structure of a Sof-Lex disk deteriorates rapidly.7

The amount of enamel that can be safely removed remains a controversial question.19,20 Based on a minimum enamel thickness of .36mm for the mandibular anterior teeth, Hudson suggested a maximum removal of .25mm per surface from the incisors and .3mm from the canines,21 while Barrer allowed as much as .5mm per surface to be stripped from the mandibular incisors.22 On the other hand, Fillion warned against removing more than .2mm of enamel.19 While the smallest-diameter bur he advocated for stripping was .18mm, the disks used in our study measure only .15mm. We found an additional enamel reduction of .05-.1mm after polishing with Sof-Lex XT disks and of .1-.15mm after using the three tungsten carbide burs. Therefore, it appears safer to remove enamel with disks than with burs.

Conclusion

Interproximal enamel reduction has been widely accepted by clinicians and researchers. 3,4,15,17,19 The present study demonstrates that even smoother enamel can be achieved than has been shown in previous studies.10,19 The SEM evaluation demonstrates satisfactory results using oscillating perforated diamond-coated disks for stripping and fine and ultrafine Sof-Lex XT disks for polishing. We believe even larger-diameter Sof-Lex disks would reach the cervical areas more easily and thus produce optimal results. This method is simple and clinically expedient, involving only three steps. However, stripping must be also be comfortable for the patient. The perforated diamond-coated disk in an oscillating handpiece at moderate speed oscillates only about 60°, making injuries unlikely and eliminating the need for lip and cheek protectors (Fig. 1C).

ACKNOWLEDGMENTS: The authors wish to thank Mrs. A. Kähler and Mrs. B. Scheidereiter for their expert technical assistance in processing the SEM specimens. In addition, we wish to thank Dr. Saskia Liebmann for her assistance in preparing the manuscript.

FIGURES

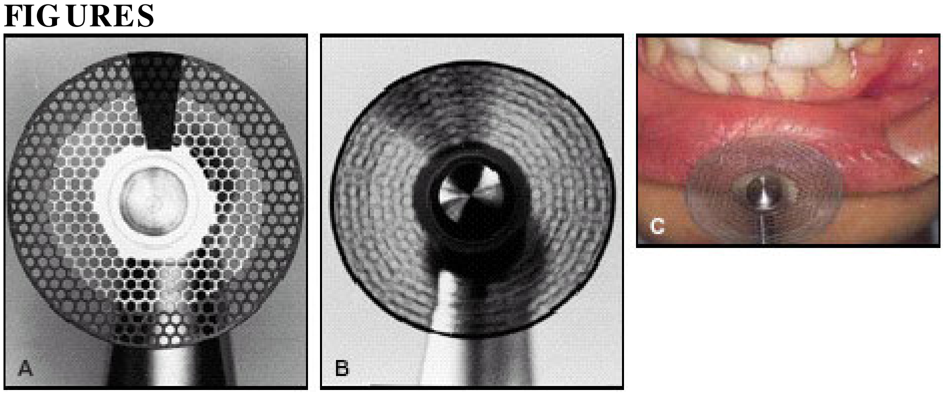

Fig. 1 Perforated diamond-coated disk used for stripping. B. In oscillating handpiece, disk oscillates only about 60°. C. Oscillating mode makes soft-tissue injuries unlikely, eliminating need for lip and cheek protectors.

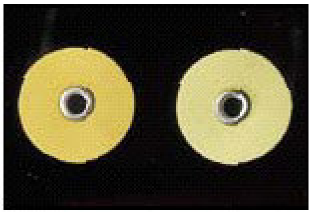

Fig. 2 Sof-Lex XT disks, fine (left) and ultrafine (right), used for polishing.

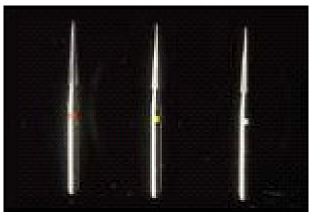

Fig. 3 Three tungsten carbide burs used for polishing.

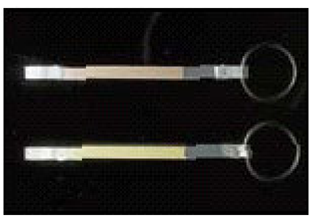

Fig. 4 Oscillating Elastrips, fine (top) and ultrafine (bottom), used for polishing.

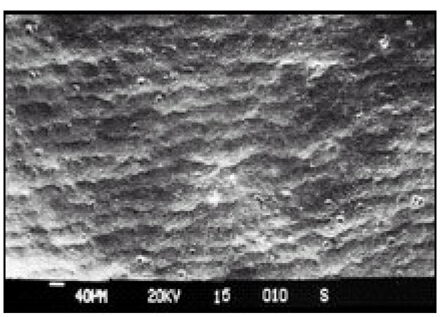

Fig. 5 Untreated enamel surface.

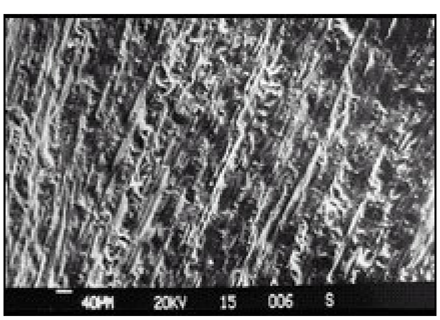

Fig. 6 Enamel surface after stripping with diamond bur: furrows uniformly distributed over

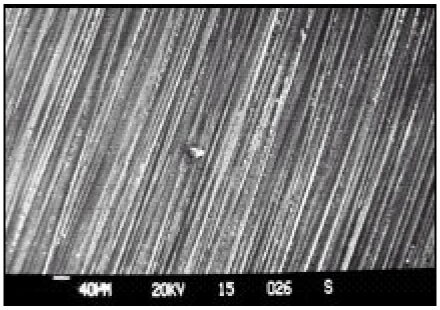

Fig. 7 Enamel surface after stripping with oscillating perforated diamond-coated disk: grooves small and uniformly distributed.

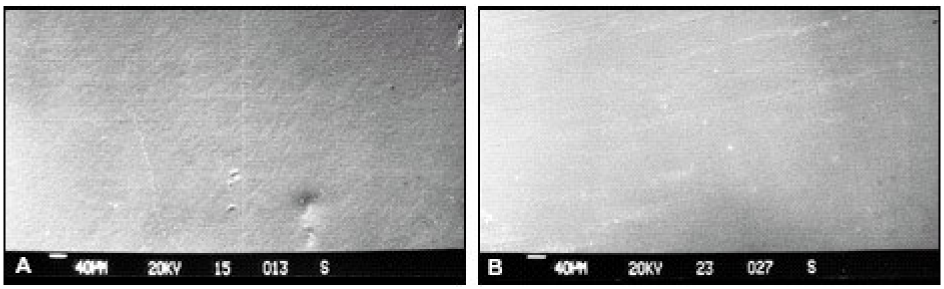

Fig. 8 A. Enamel surface after stripping with diamond bur and polishing with fine and ultrafine Sof-Lex XT disks for 40 seconds each: surface smoother than untreated enamel. B. Insufficient polishing in cervical region produces furrows alternating with well-polished areas.

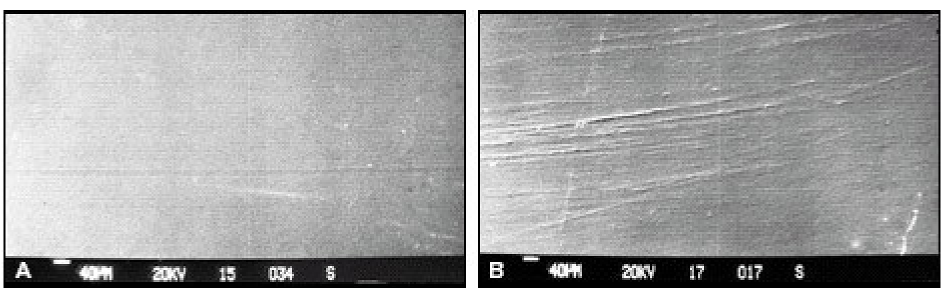

Fig. 9 A. Enamel surface after stripping with oscillating perforated diamond-coated disk and polishing with fine and ultrafine Sof-Lex XT disks for 40 seconds each. B. Roughest area (cervical) of same proximal surface after polishing.

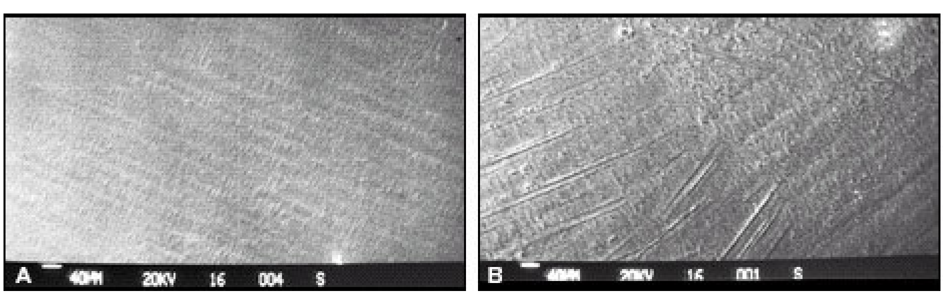

Fig. 10 A. Enamel surface after stripping with perforated diamond-coated disk and polishing with three tungsten carbide burs. B. Roughest area (cervical) after polishing.

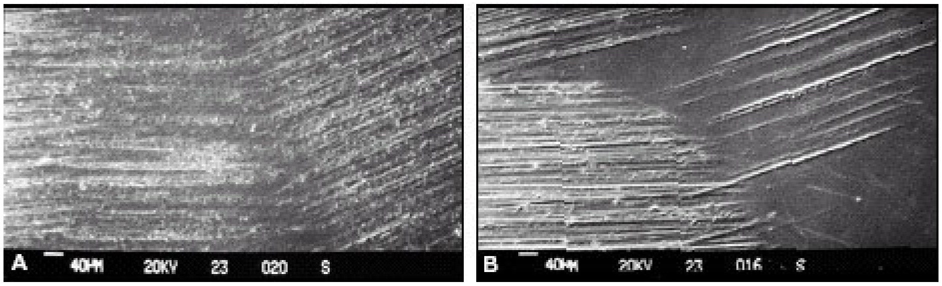

Fig. 11 A. Enamel surface after stripping with perforated diamond-coated disk and polishing with two oscillating Elastrips for 40 seconds each. B. Enamel surface after same stripping procedure, with Elastrips used for 20 seconds each.

TABLES

TABLE 1
INSTRUMENTS AND METHODS

Group	Stripping	Polishing	Time
A1	Diamond-coated bur	Sof-Lex XT disks (fine, ultrafine)	40 seconds
A2		3 tungsten carbide burs	
A3		Oscillating Elastrips	
B1	Perforated diamond-coated disk	Sof-Lex XT disks (fine, ultrafine)	40 seconds
B2	Rotating	3 tungsten carbide burs	
B3	(grain size <30 microns)	Oscillating Elastrips	
C1	Perforated diamond-coated disk	Sof-Lex XT disks (fine, ultrafine)	40 seconds
C2	Oscillating	3 tungsten carbide burs	
C3	(grain size <30 microns)	Oscillating Elastrips	
D1	Perforated diamond-coated disk	Sof-Lex XT disks (fine, ultrafine)	20 seconds
D2	Oscillating	3 tungsten carbide burs	
D3	(grain size <30 microns)	Oscillating Elastrips	

Table. 1

REFERENCES
1 Ballard, M.L.: Asymmetry in tooth size: A factor in the etiology, diagnosis and treatment of malocclusion, Angle Orthod. 67-70, 1944.

2 DiPaolo, R.J. and Boruchov, M.J.: Thoughts on stripping of anterior teeth, J. Clin. Orthod. 5:510-511, 1971.

3 Sheridan, J.J.: Air-rotor stripping, J. Clin. Orthod. 19:43-59, 1985.

4 Sheridan, J.J.: Air-rotor stripping update, J. Clin. Orthod. 21:781-788, 1987.

5 Zachrisson, B.U.: JCO Interviews on excellence in finishing, Part 2, J. Clin. Orthod. 20:536-556, 1986.

6 Bennett, J.C. and McLaughlin, R.P.: Betrachtungen zur Kronenform der Schneidezähne bei der kieferorthopädischen Behandlung, Inf. Orthod. Kieferorthop. 29:255-266, 1997.

7 Jost-Brinkmann, P.G.; Otani, H.; and Nakata, M.: Surface condition of primary teeth after approximal grinding and polishing, J. Clin. Ped. Dent. 16:41-45, 1991.

8 Rodgers, G.A. and Wagner, M.J.: Protection of stripped enamel surfaces with topical fluoride applications, Am. J. Orthod. 56:551-559, 1969.

9 Kapur, K.K.; Fischer, E.; and Manly, R.S.: Effect of surface alteration on the permeability of enamel to a lactate buffer, J. Dent. Res. 40:1174-1182, 1961.

10 Radlanski, R.J.; Jäger, A.; Schwestka, R.; and Bertzbach, F.: Plaque accumulations caused by interdental stripping, Am. J. Orthod. 94:416-420, 1988.

11 Bennett, J.C. and McLaughlin, R.P.: Orthodontic Management of the Dentition with the Preadjusted Appliance, Isis Medical Media Ltd., Oxford, England, 1997.

12 Piacentini, C. and Sfondrini, G.: A scanning electron microscopy comparison of enamel polishing methods after air-rotor stripping, Am. J. Orthod. 109:57-63, 1996.

13 Puigdollers, A.: Rasterelektronenmikroskopische in-vitro-Vergleichsstudie der Auswirkungen des Beschleifens (Strippens) des Schmelzes bleibender Zähne von Hand und mit fer Luftturbine, Inf. Orthod. Kieferorthop. 30:511-527, 1998.

14 Radlanski, R.J.; Jäger, A.; and Zimmer, B.: Morphology of interdentally stripped enamel one year after treatment, J. Clin. Orthod 23:748-750, 1989.

15 Hein, C. and Jost-Brinkmann, P.G.: Oberflächenbeschaffenheit des Schmelzes nach approximalem Beschleifen?Rasterelektronenmikroskopische Beurteilung unterschiedlicher Polierverfahren, Fortschr. Kieferorthop. 51:327-335, 1990.

16 Joseph, V.P.; Rossouw, P.E.; and Basson, N.J.: Orthodontic microabrasive reproximation, Am. J. Orthod. 102:351-359, 1992.

17 Sheridan, J.J. and LeDoux, P.M.: Air-rotor stripping and proximal sealants: An SEM evaluation, J. Clin. Orthod. 23:790-794, 1989.

18 Tell, R.T. and Sydiskis, R.J.: Longterm cytotoxicity of orthodontic direct-bonding adhesives, Am J. Orthod. 93:419-422, 1988.

19 Fillion, D.: Vor- und Nachteile der approximalen Schmelzreduktion, Inf. Orthod. Kieferorthop. 27:64-89, 1995.

20 Stroud, J.L.; English, J.; and Buschang, P.H: Enamel thickness of the posterior dentition: Its implications for nonextraction treatment, Angle Orthod. 68:141-146, 1998.

21 Hudson, A.L.: Astudy of the effects of mesiodistal reduction of mandibular anterior teeth, Am. J. Orthod. 42:615-624, 1965.

22 Barrer, H.G.: Protecting the integrity of mandibular incisor position through keystoning procedure and spring retainer appliance, J. Clin. Orthod. 9:486-494, 1975.

FOOTNOTES

1 Diamond-coated bur, Model No. 5FG166, Horico, Berlin, Germany.

2 Perforated diamond-coated disk, Komet, grain size < 30 microns, Brasseler, Lemgo, Germany.

3 Oscillating handpiece, Model No. 962A-H, W&H, Muster, Austria.

4 Sirona S motor, Siemens, Bensheim, Germany.

5 Sof-Lex XT disks, Model Nos. 2382F and 2382SF, 3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016.

6 Tungsten carbide burs, Komet Model Nos. H135, H135F, and H135UF, Brasseler, Lemgo, Germany.

7 Elastrips, Model Nos. 163 and 164, Hawe Neos Dental, Bioggio, Switzerland.

8 Vinyl polysiloxane, President Plus Jet light body, Coltene AG, Altstätten, Switzerland.

9 Epoxy resin, Stycast, Grace Specialty Polymers, Grace N.V., Belgium.

10 Gold, Bal-TEC GmbH, EM-Technologie und Applikation, Schalksmühle, Germany.

11 Scanning electron microscope, Leica, Cambridge Instruments GmbH, Berlin Spandau, Germany