

EFFECT OF VARIOUS SCALING AND CONDITIONING PROCEDURES ON PERIODONTALLY AFFECTED HUMAN ROOT SURFACES: A SCANNING ELECTRON MICROSCOPIC STUDY*

Nadir Babay, BCD, MSD, DCD;*

Axel Bergeholtz, DDS, Dr. Odont (PhD), Cert. Perio, Oral Surg**

تهدف الدراسة لفحص مظهر سطوح جذور الأسنان ذات إصابة حول سنّية وذلك بعد إجراء التقلّيح اليدوي واستعمال نوعين مختلفين من أجهزة التقلّيح الفوق صوتية (البيزون الكهربائي) ومن ثمّ تمت معالجتهم بمحلول ملحي، حمض الليمون المشبع، كلور التتراسيكلين المشبع أو (أى . دي . تى . آى) بنسبة ٨٪. شملت الدراسة ١٨ عينة من الجذور مأخوذة من ١٨ سن تمّ قلعها بسبب الإصابة حول السنّية حيث تمّت معالجتها وفقاً للإجراءات المذكورة أعلاه مع وجود عينات موافقة لم تخضع للمعالجة، استخدمت للمقارنة. تمّ اختيار العينات بشكل عشوائي. دلت المشاهدات عدم وجود فرق واضح بين سطوح الجذور المخرّشة والمخلّبة وبين تلك التي لم تتعرض للتخريش أو التخلّيب. حيث بدت سطوح الأولى مدببة على شكل نهاية الأبرة مع تشكلات شبيهة بفوهة البركان.

The purpose of the present study was to investigate the appearance of periodontally involved root surfaces after hand scaling and after using two different piezoelectric ultrasonic scalers. Further, the root surfaces were examined by a scanning electron microscope after they have been treated with saline, saturated citric acid, saturated tetracycline hydrochloride or 8% EDTA for 3 minutes. Thirty-seven root specimens from the "diseased" part of nine periodontally-involved human permanent teeth were analyzed after they have been treated according to the above-mentioned procedures with corresponding controls (non-treated) in a randomized order. The observations made indicated no differences among the three scaling devices, but significant differences among etched, or chelated, and non-etched, or non-chelated, root surfaces with the former showing needle-pointed surfaces and crater formations.

The microorganisms involved in caries and periodontitis are dependent on adhesion and/or non-shedding surfaces to survive. Normally, there is a dynamic equilibrium between retention forces of microorganisms and removing forces. Selective

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*Assistant Professor, Department of Preventive Dental Sciences, King Saud University College of Dentistry

**Professor, Department of Preventive Dental Sciences, King Saud University College of Dentistry, P.O. Box 60169, Riyadh 11545, Saudi Arabia.

Address reprint requests to: Dr. N. Babay

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adhesion and stagnation are mechanisms which favor retention of microorganisms that can cause inflammation in the periodontal tissues.¹² In an overview article, Quirynen and Bollen³ discussed the influence of surface roughness and surface-free energy on supra- and sub-gingival plaque formation in man. They concluded that both the free energy and roughness of intra-oral hard surfaces have a major impact on the initial adhesion and retention of oral microorganisms. Supragingivally rough surfaces and surface-free energy resulted especially in faster bacterial colonization and maturation of plaque. Subgingivally, the influence of these forces

are far less. The dominant effect of surface roughness demands far "more clinical attention"

The purpose of the present study was to investigate the appearance of periodontally involved root surfaces after handscaling using a LM Gracey curette 11/12,* and after using two different piezoelectric ultrasonic scalers, namely Piezon** and Amdent.*** Another aim was to investigate these surfaces after they have been treated with saline, saturated citric acid, saturated tetracycline hydrochloride or 8% EDTA for 3 minutes using a scanning electron microscope.

Materials and Methods

Selection of Teeth

Nine extracted, periodontally involved single-rooted human permanent teeth were used in this study. The teeth were rinsed in tap water and placed in tubes containing saline. The saline was changed every third day for 2 months during the collection of teeth. Teeth were free from caries, cervical restorations or erosions and were selected according to the criteria recommended by Garrett et al⁴ which were: a) loss of attachment greater than 6 mm; b) no scaling or root planing for at least 6 months prior to extraction; c) radiographic evidence of at least 50% bone loss; and d) sensitivity to cold.

The teeth were cleaned with a medium hard bristle toothbrush to remove debris after which they were washed thoroughly with distilled water. Only the diseased part of the root surface was used in the study.

The teeth were randomly divided into three groups and controls were obtained by not instrumenting half of each buccal surface area on all teeth. The other half was scaled with either hand instruments or either of the piezo electric scalers. The solutions used for the treatment of the root surface were saline, saturated citric acid (pH 1.0), saturated tetracycline hydrochloride (pH 1.8), 8% EDTA dissolved in PBS solution (pH 7.3). The conditioning time was 3 minutes. Test and control areas were marked with a notch to ascertain the coronal direction.

Group 1: The root surfaces were treated with a Gracey 11/12 curette (LM) machine sharpened (600 grain under tap water) at a rotation speed of 30 rpm

until a smooth root surface was obtained.

Group 2: The root surfaces were treated with back and forth strokes of an EMS piezo-electric scaler until a smooth root surface was obtained. The power setting was medium.

Group 3: The test surfaces were identically treated as in Group 2, except for the use of Amdent piezo-electric scaler. After scaling, each tooth was cut into two pieces each by 3 mm long. Each specimen was placed in a 96 well-microliter plate.* A total of 37 specimens representing 36 test/control surfaces and one unsealed and nonconditioned surface control were placed and registered according to the root treatment performed. Each group was equally represented by a total of 12 specimens. The wells selected for root treatment were filled with either saline, saturated citric acid, saturated tetracycline hydrochloride or 8% EDTA according to the randomization. After 3 minutes, the solutions were removed by suction and the specimens were rinsed with distilled water and fixed in 2.5% glutaraldehyde for 2 weeks.^{5,6}

Specimens for scanning electron microscopy:

All specimens were prepared for scanning electron microscopy. After fixation, dehydration was performed in a graded series of ethanol with 100% acetone as a final step. Each of the sectioned pieces was mounted on an aluminum stub gold coated with a sputter technique and examined in a scanning electron microscope,** operated at 25 KV and at a tilt angle between 0 and 30 degrees.⁷

Results

Controls (non-scaled specimens)

The untreated "diseased" root surface was covered with lumps of dental calculus in between which the surfaces appeared smooth [Fig. 1]. When the controls were treated with either saline, acids or EDTA chelator, the root surfaces were not visibly affected.

LM 11/12 curetted root surfaces

All LM 11/12 instrumented root surfaces showed a smooth, regular surface. In one specimen, longitudinal grooves measuring 100/p.m in width

*LM Abo, Finland

**Piezon, EMS, Switzerland

***Amdent, Sweden

*Honeycombplates, Labssystem, Finland

**Jeol, Tokyo, Japan

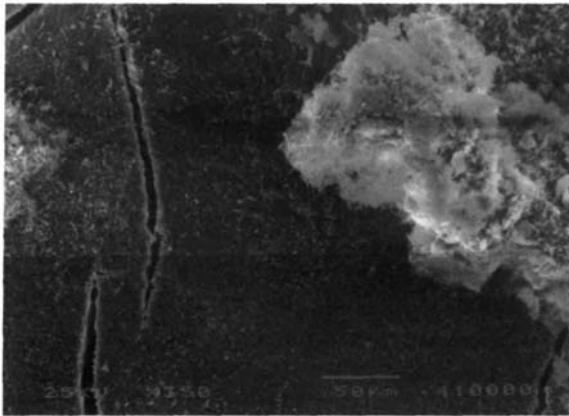


Figure 1. Untreated periodontally diseased root surface. Calculus covers the upper third of the root. The apical part has a smooth appearance. (SEM; original magnification x 350).

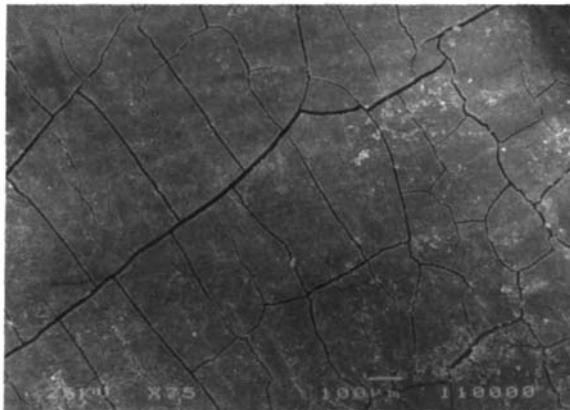


Figure 2. Saline, LM 11/12 instrumented root surface is smooth, however, two longitudinal grooves left by earlier instrumentation were observed. (SEM; original magnification x 75).

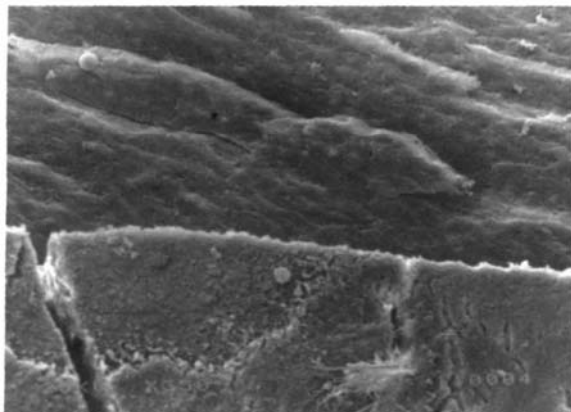


Figure 3. Root planed with LM 11/12 and conditioned with EDTA for 3 minutes: the left side of the figure shows exposed dentin with a ruffled appearance, while the other half is cracked cementum with a granular appearance. (SEM; original magnification x 350).

were detected at a magnification of 75X or more [Fig. 2]. The etched surfaces as well as the chelated ones showed a ruffled appearance [Fig. 3].

Amdent ultrasonic treated root surfaces

The Amdent-treated specimens presented uniform, flat, smooth surfaces even at a magnification of X3500. Small dust-like particles could be detected on the surfaces [Fig. 4]. The etched or chelated root surfaces exhibited crater defects with rough needle-pointed surfaces [Fig. 5].

Piezon ultrasonic treated surfaces

The appearance of the root surfaces treated with the Piezon ultrasonic device was similar to the Amdent-treated and the etched or chelated ones.



Figure 4. Saline, Amdent ultrasonic treated root surface exhibits an amorphous appearance with no evidence of Sharpey's fiber insertion and dentinal tubules. Dust like particles are present. (SEM; original magnification x 3500).

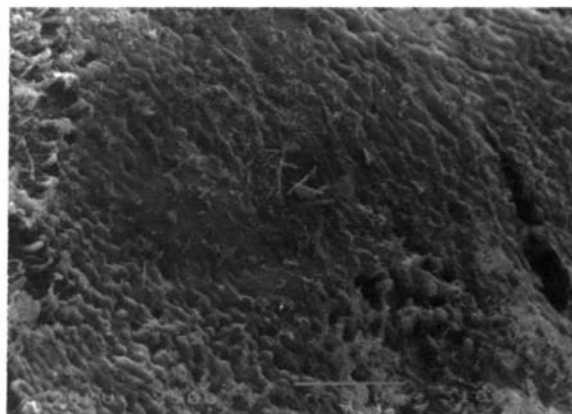


Figure 5. Piezon treated root surface and conditioned for 3 minutes with citric acid: the root surface has a granular appearance and is undulated. Circular openings are seen penetrating the cementum. (SEM; original magnification x 500).

Discussion

The present investigation was performed as an in vitro pilot study to evaluate different scaling devices and etching procedures used in daily clinical practice to remove calculus and smear layer. The teeth were scaled and root-planed longitudinally without any standardized pressure starting at the most apical area earlier exposed to the oral environment. A device is under construction to standardize the pressure during scaling as advocated by Bjorn & Lindhe⁸ who claimed that pressures above 50-100 psi using hand instruments will create rougher root surfaces. The results obtained in the present study showed that the root surfaces treated with piezo-electric devices as well as with hand instruments appeared smooth and regular. This is in contrast with the findings of Bye et al⁹ who found that hand instruments created a smoother root surface than the ultrasonic devices (Piezon and Cavitron).

In 1984, Poison et al¹⁰ stated that the removal of the smear layer with citric acid may enhance the chance for new attachment by removing all debris from the root surfaces in contact with the periodontal tissues. The presence of a smear layer will probably delay healing and prohibit new attachment. Register,⁵ Register and Burdick⁶ recommended citric acid at pH 1.0 for 2-3 minutes etching to obtain ideal conditions for new attachment. However, Blomlof et al¹¹ in their study on monkeys found that 3 minutes etching with citric acid causes delayed periodontal healing and loss of alveolar bone. The same authors¹² showed that etching for 20 seconds promoted repair as new connective tissue was formed in areas which had been exposed earlier to the oral environment.

The application of citric acid has been performed in different ways. In the present study, the test specimens were submerged in acids or a chelator. However, scrubbing with a soaked cotton-pellet would probably be more effective in removing the smear layer in a shorter time thus avoiding deleterious etching effect on the rootsurface.¹³

This study has shown that root surface characteristics after etching differed from those which have only been scaled and root planed. However, there seems to be a difference in the demineralization depending on which acid or chelator have been used. In all cases, 3 minutes

etching caused crater formations with a rough needle-pointed surface. This change in the topography of the root surfaces may be limited to in vitro conditions, as in vivo other mechanisms may be present which may alter the etching effect. In 1993, Chaves et al¹⁴ showed two cases where zones of supposed over-demineralization appeared after application of citric acid for 3 minutes. They claimed that over-demineralization depends on "over concentration of citric acid"; various root surfaces areas where grooves or concavities occur. In our study, application of citric acid for 3 minutes caused crater formation which supports the above findings.

Long time etching has also been correlated to increased inflammatory pulpal response as well as pulpal necrosis in cats permitting penetration of bacteria through enlarged dentinal tubuli.¹⁵

Differences between our results and other in vitro studies may be related to the extent of instrumentation, exposure time to demineralization agents, treatment time after extraction, and the way teeth have been stored or a combination of all these variants.

Conclusion

Within the limits of the present in vitro study the following can be concluded:

1. Piezo-electric ultrasonic devices and hand scaling with root planing produce smooth root surfaces.
2. Etched or chelated root surfaces show a needle-pointed appearance and, in some areas, crater defects not detectable in non-etched or non-chelated specimens.
3. Three minutes etching or chelating time, at a pH of 1.0 - 1.8, was found to be too long a duration for demineralization in vitro.

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