In Vitro Evaluation of the Root Surface Microtopography Following the Use of Two Polishing Systems by Confocal Microscopy (CFM) and Scanning Electron Microscope (SEM)

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Abstract

Objectives: To compare and evaluate the root surface roughness after using two polishing instruments for root planing.

Materials and Methods: This comparative study was carried out on a sample of ten extracted human teeth with twenty interproximal root surfaces.

Control group 1 and 2: (n=20 root surface): Gracey Curettes, 15 vertical strokes.

Test group 1 (n=10): control group 1 + Termination Diamond Curettes (TDC), 15 strokes.

Test group 2 (n=10): control group 2 + Termination Diamond Burs -15 µm (TDB), with irrigation for 15 seconds at 3000 rpm.

The root surface was planed with the polishing instruments and test measurements were obtained with Confocal Microscopy (CFM) and Scanning Electron Microscope (SEM).

The primary outcome variable was surface roughness (Ra).

Results: CFM showed that the TDC, mean changes in surface roughness (Ra) were reduced by 0.11 ± 0.14 (*p-value* = 0.000), and the TDB, Ra: were reduced by 0.27 ± 0.86 (*p-value* = 0.037). Non-statistically significant differences were observed in Ra (*p-value* = 0.581) between the two polishing instruments.

SEM showed that the Group 2 showed a generally rougher surface with more parallel grooves than Group 1.

Conclusion: There are no statistically significant differences between these two polishing systems, although TDB seems to reduce the surface roughness more than the TDC after being treated with Gracey Curettes.

Key Words: Root Planing, Root Microtopography, Roughness, Termination Diamond Curettes, Termination Diamond Burs

Introduction

One aim of periodontal therapy is to achieve a root surface conducive to the maintenance of healthy periodontal tissue. There is a general consensus that the smoother the root surface is the better the clinical results will be [1-4]. A smooth root surface may be advantageous near the gingival margin, since this type of surface is less likely to accumulate plaque than a rough surface, and plaque removal is more effective with a smooth rather than a rough surface. Studies in animals by Leknes et al. [2,3] as well as in the studies of Quirynen et al. [4] and Atilla and Kandemir [5] concluded that surface roughness resulting from subgingival instrumentation had a significant influence on subgingival microbial colonization. Therefore a smooth root surface is one objective for successful scaling and root planing treatment.

Although hand scalers and ultrasonic devices are frequently used in this procedure, and it is known that curettes successfully create a smooth root surface that is biocompatible for healing [6-9], numerous alternatives to instrumentation have been advocated [10].

At present, Termination Diamond Burs® and Termination Diamond Curettes® are being used for scaling and root planing and have been used in combination with curettes and ultrasonic scalers.

To our knowledge, there is minimal data available pertaining to studies on Termination Diamond Burs and there is no literature on Termination Diamond Curettes after root debridement. Hence, this study was aimed at comparing the root planing effectiveness of the two polishing instruments after scaling and root planing with Gracey Curettes. The hypotheses were that these two polishing systems reduce root surface roughness after scaling and root planing with conventional curettes and that no differences are observed in root surface roughness between the two polishing systems.

Material and Methods

Study sample

A total of ten extracted human teeth with twenty interproximal root surfaces were used in the study. Multiradicular teeth, teeth with root surface caries or external resorption, and teeth with restorations on root surface were not included.

The study was conducted at the Research Laboratory of the Universitat Internacional de Catalunya, Barcelona, Spain and at The Scientific-Technical Services UB (SCT-UB) of the Universitat de Barcelona, Barcelona, Spain.

Study design

This is a comparative, *in vitro*, single blind study on scaling and root planing between Termination Diamond Curettes (Intensiv Perio Set®, Grancia, Switzerland) and Termination

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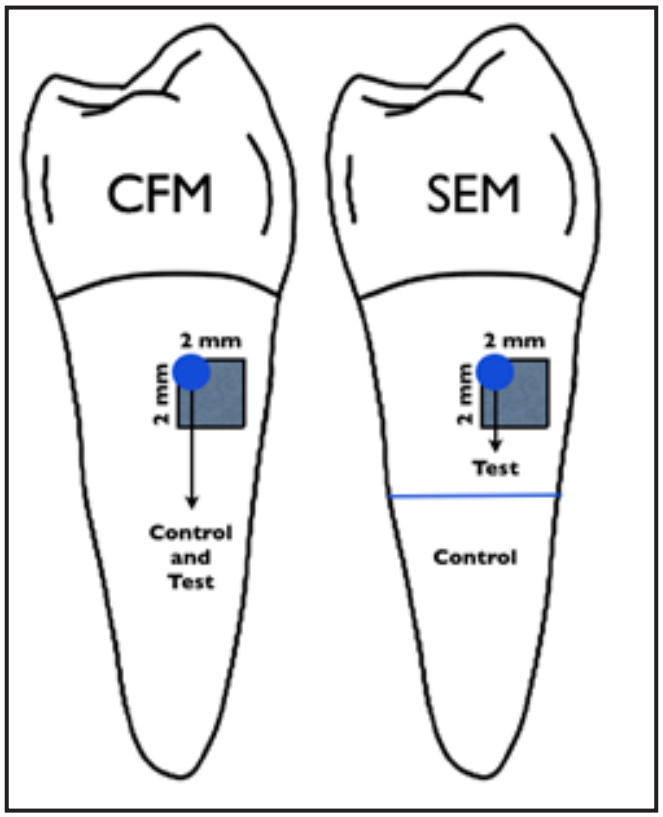
Diamond Burs (15 µm) (Intensiv Perio Set®, Grancia, Switzerland) in combination with Gracey Curettes (Hu - Friedy®, Chicago, IL, USA).

All teeth were free of calculus and were conserved in sodium chloride (*NaCl*) -0.9% isotonic solutions (B. Braun Medical S. A., Rubí, Barcelona). During the study, the solution was changed every 5 days, to avoid contamination of solution. The teeth were numbered 1-10 for identification and catalogued.

The control group comprising twenty interproximal root surfaces were randomly assigned and divided into two control groups of ten surfaces each. The two control groups served as the two test groups. For consistency and precision, an 2×2 mm area was drawn on the coronal third of each interproximal root surface and a marked (*Figure* 1) with a thin cylindrical bur (Komet®, Lemgo, Germany) in the upper left corner of the box (2×2 mm area) as a reference point for analysis with the light microscope. This mark defined both the control areas and test areas.

Control group 1 and 2: Gracey Curettes, 15 vertical strokes with movements from the most apical point to the most coronal root surface point [11].

Test group 1: Gracey curettes, 15 strokes as mentioned in the control group 1, followed by Termination Diamond Curettes, 15 vertical strokes with movements from the most apical point to the most coronal root surface point [11].



CFM: control and test measurements were obtained in the same point (blue circle) of a 2×2 mm area, on the coronal third of each root.
SEM: a mark was made with a cutting dental disc on the middle of the root to delineate two areas: the inferior part corresponding to the control and the superior part corresponding to the test.

Figure 1. *Work Area Diagram.*

Test group 2: Gracey curettes, 15 strokes as mentioned in the control group 2, and Termination Diamond Burs -15 µm for contra angle handpieces, with irrigation for 15 seconds at 3000 rpm. Movements were made parallel to the axis of each tooth.

One operator (CSM) performed all scaling and root planing procedures. A second blind operator (AV) evaluated the samples with Confocal Microscopy (CFM) (Leica Microsystems Barcelona, Spain), in addition to Scanning Electron Microscope (SEM) (Leica Microsystems Barcelona, Spain) at the Scientific-Technical Services UB (SCT-UB) of the Universitat de Barcelona.

CFM

Gracey curettes were used to perform scale and root planing before taking control measurements with CFM. Subsequently the root was planed with Termination Diamond curettes and Termination Diamond burs -15 µm. Test measurements were obtained with CFM on the coronal third of each root (*Figure* 1) in the same point where the control measurements were taken.

In order to conduct a CFM evaluation, the samples were dried and placed horizontally in a silicone block. The silicone moulds were originally designed for all the interproximal root surfaces (sides A and B, previously assigned to each group) of each tooth selected in the study groups (modification of the protocol used by Busslinger et al. [12]). Finally, each surface was observed at magnification X20.

The CFM provides a three-dimensional image of the structures and quantitative roughness values. Five partial surfaces profiles for each sample were randomly assigned in order to obtain a mean surface roughness (Ra).

The equipment was calibrated in accordance with the manufacturer's specifications (Leica Microsystems).

SEM

To evaluate the sample for the SEM, scaling and root planing were performed on each interproximal root surface and marked with a cutting dental disc (Komet®, Lemgo, Germany) on the middle of the root to delineate two areas: the inferior part corresponding to the control and the superior part corresponding to the test (*Figure* 1).

Since different sample preparations are needed for each of the microscopes, the control and test measurements for the SEM were taken after completion of all the examinations with the CFM. The specimens were first dried completely and gold-sputtered. The surfaces were then examined at magnifications ranging from X50 to X1000.

Statistical analysis

The means and standard deviations were calculated and statistical analysis between the means was performed with factorial analysis of variance. The primary outcome variable was surface roughness (Ra). The statistical analysis was carried out with a statistics computer program (SOFA statistics

software) on a Macintosh computer. The level of significance was determined at p-value of 0.05.

Note that the statistical analysis was performed with the surface roughness value obtained through the confocal microscopy. The average values of reductions in roughness amongst the groups and within the groups were tested before and after instrumentation.

Table 1. *Mean value of surface roughness (Ra).*

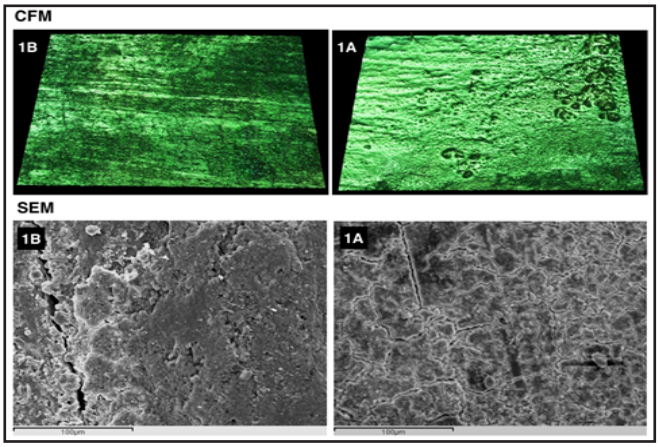
GROUPS	Control 1	Test 1	Control 2	Test 2
Mean	0.44	0.33	0.75	0.48
Std Dev	0.17	0.09	0.87	0.23
Min	0.209	0.216	0.216	0.309
Max	0.926	0.582	4.771	1.341
Range	0.717	0.366	4.555	1.032

The mean value (Ra) in µm, the standard deviation (Std Dev), minimum roughness value (Min), maximum roughness value (Max) and the data range (Range) per group are shown. (Control 1 and 2) Gracey Curettes, (Test 1) Termination Diamond Curettes and (Test 2) Termination Diamond Burs-15 µm.

Table 2. *The mean value change of surface roughness (Ra).*

GROUPS	1	2
Mean	-0.11	-0.27
Std Dev	0.14	0.86
Min	-0.3116	-2.7366
Max	0.149	0.6704
Range	0.4606	3.407

The mean value change of surface roughness (Ra) in µm, the standard deviation (Std Dev), minimum roughness value (Min), maximum roughness value (Max) and the data range (Range) per group are shown. (1) Gracey Curettes + Termination Diamond Curettes and (2) Gracey Curettes + Termination Diamond Burs-15 µm. Note that on the role "Mean" the minus sign (-) means that the roughness reduced in the groups.

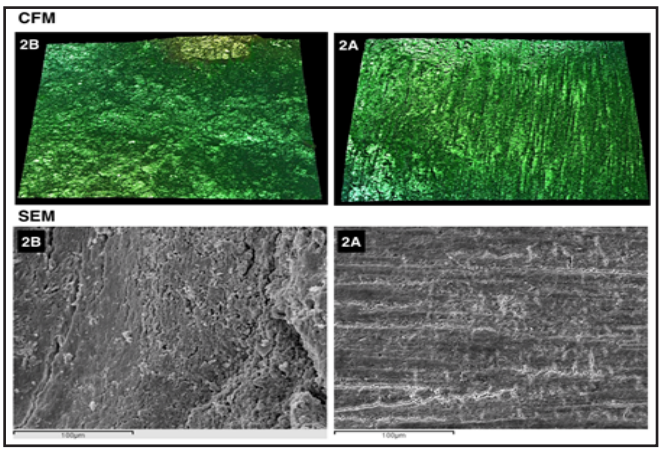


Confocal Miscrocopy (CFM). X20 Three-dimensional reconstruction of a 2 × 2 mm area of root surface. Note that the closer cool and warm colors turn green and shadows tend to disappear as the surfaces becomes smoother.
(1B) Gracey Curettes, (1A) Gracey Curettes + Termination Diamond Curettes.
Scanning Electron Microscope (SEM). X500 photomicrograph of root surface.

Figure 2. *Termination Diamond Curettes (Group 1).*

Results

Ten teeth were included for evaluation, providing 20 root surfaces for the analysis.



Confocal Miscrocopy (CFM). X20 Three-dimensional reconstruction of a 2 × 2 mm area of root surface. Note that the closer cool and warm colors turn green and shadows tend to disappear as the surfaces becomes smoother.
(2B) Gracey Curettes, (2A) Gracey Curettes + Termination Diamond Burs -15 µm.
Scanning Electron Microscope (SEM) X500 photomicrograph of root surface.

Figure 3. *Termination Diamond Burs -15 µm (Group 2).*

CFM

The initial mean Ra values and standard deviations for control group 1 and control group 2 were 0.44 ± 0.17 and 0.75 ± 0.87 respectively. After scaling and root planing with the test instruments, the mean Ra values and standard deviations were reduced in the two instruments: to 0.33 ± 0.09 in test group 1, being statistically significant (p-value = 0.000) and in test group 2 to 0.48 ± 0.23, also being statistically significant (p-value = 0.037) (*Tables* 1 and 2).

Although the Termination Diamond burs seem to reduce surface roughness more than the Termination Diamond Curettes, the difference between the two polishing instruments is statistically insignificant (p-value = 0.581).

The three-dimensional images obtained with CFM showed that the two polishing instruments left a smoother surface after treatment, which is demonstrated by a more homogenous green colour with fewer shades. In addition, the images in test group 2 showed parallels grooves, which were not as perceptible as in test group 1 (*Figure*s 2 and 3).

SEM

SEM showed that in all specimens of the two groups a smoother surface was observed after root planing with the two polishing instruments. The images illustrated that before treatment all surfaces had gouges, which were not perceptible after root polishing with the Termination Diamond Curettes and the Termination Diamond Burs -15 µm. The control group (Gracey curette) also revealed short extended filopodia, which were not observed in the test groups (Gracey curette + polishing system) (*Figure*s 2 and 3).

Furthermore, after root planing with Termination Diamond Curettes and Termination Diamond Burs, parallel grooves running in the direction of the instrumentation were observed in all surfaces. Note that teeth treated with a combination of

hand scalers (Test group 1) showed surfaces with relatively few parallel grooves (*Figure* 2).

Discussion

The root surface roughness created by different debridement instrumentation varies considerably. Clinically, root surface smoothness is assessed by the sense of touch using a periodontal probe or the sharp edge of a curette. Atilla et al. [7] developed a study to evaluate how much roughness is accep*table* for defining a surface smoothness by periodontists and for obtaining the roughness value of cementum considered to be smooth using the sense of touch. In this way, the study determined whether or not the required smoothness has been attained. This remains a matter of controversy [7].

Ten cylindrical metal samples of equal sizes were used in the study by Atilla et al. [7] and the evaluation of roughness was carried out by periodontists and a profilometer. They concluded that all the surfaces with a roughness value below 2.12 were accepted as smooth, while those possessing values above 3.57 were considered rough. These findings corroborate those of other researchers [13-15]. In accordance with these data, our final values were below 2.12 after root planing with the two instruments, 0.33for Termination Diamond curettes, and 0.48 for Termination Diamond Burs. The two instruments left smooth surfaces after the treatment.

Schlageter et al. [10] conducted a study *in vivo* on teeth for extraction for periodontal reasons. They compared: Gracey curettes, sonic scaler, motorized universal curette, piezo ultrasonic scaler and rotating fine diamond stones (75 µm and 15 µm), using a planimetry apparatus. They observed that the rotating fine diamond stone-15 µm produced the smoothest surface and the sonic scaler the roughest surface [10]. For this reason, they concluded that if this tendency to create a smooth root surface prevails, the results of their study would indicate that the instruments of choice for root planing must include fine diamond stones in the handpiece, as well as hand curettes and Perioplaner curettes.

The authors of the present study suggest the inclusion of Termination Diamond burs and the Termination Diamond Curettes for root planning in accordance with Schlageter et al. [10].

To our knowledge, no study has been published comparing these 2 polishing instruments using Confocal Microscopy and Scanning Electron Microscope. However, comparisons with other studies should be taken with caution. Different methodologies could lead to divergent conclusions, since the type of evaluation (profilometer, laser Doppler or SEM evaluation) and the determination of the analysis area, have been shown to directly affect the results [16,17].

Conclusions

Within the limits of this *in vitro* study, we can conclude that the two polishing systems: Termination Diamond Curettes and Termination Diamond Burs -15 µm leave a smoother root surface after the root planing procedure than the applied hand scaler on its own. There are no statistically significant differences between these two polishing systems, although Termination Diamond Burs-15 µm seem to reduce the surface roughness more than the Termination Diamond curettes after being treated with Gracey Curettes.

Controlled randomized clinical studies are needed to correlate these findings with *in vivo* effects.

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